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How We May Conserve Our Metal Resources

Designers of Non-Ferrous Metal Parts Should Aid in This Movement and They Will Find a Willing Ally in the Brass Foundryman

By Charles Vickers

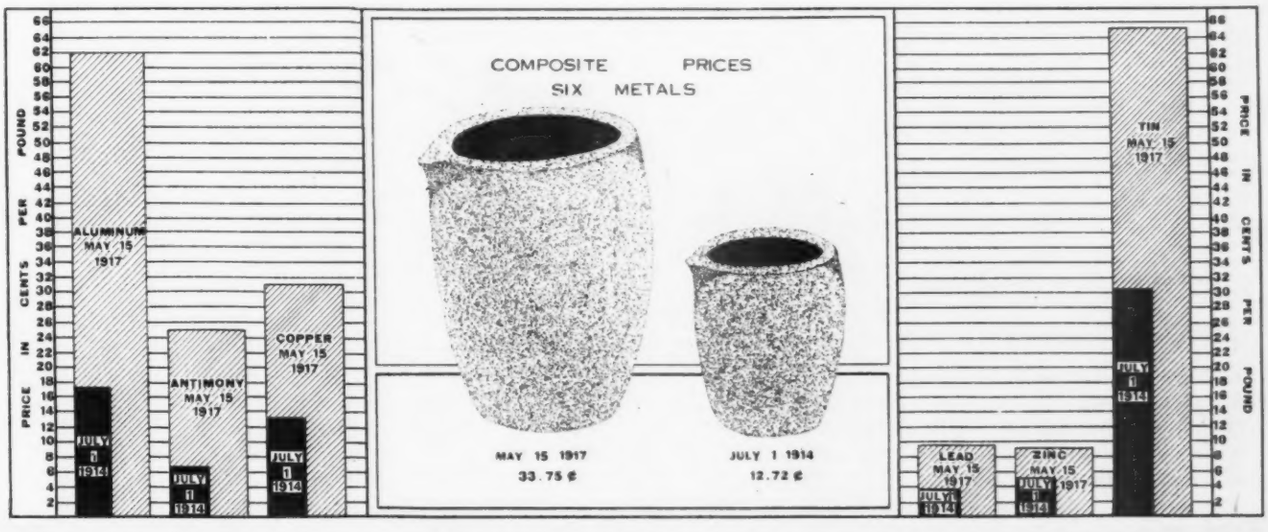
CONSTANTLY advancing prices for non-ferrous metals makes necessary the practice of their conservation today. This should receive the immediate attention of designing engineers, patternmakers and foundrymen and every effort should be made to reduce the weight of cast parts to the minimum allowable by safety and strength, and their substitution by iron and steel wherever possible.

Since the beginning of the war in 1914, the demand for non-ferrous metals has increased tremendously and prices have more than kept pace with the consumptive increment. A further increase in their use for munitions for our government has followed our entry into the war and with requirements greatly in excess of production, still higher prices are anticipated. For this reason conservation should be practiced in all commercial lines in which non-ferrous metals play a prominent part.

The accompanying chart graphically shows the increase in the prices of the six most widely used metals and compares the quotations of July 1, 1914, and May 15, 1917. It will be noted that aluminum has increased 360 per cent; antimony, 370 per cent; copper, 234 per cent; lead, 250 per cent; tin, 217 per cent, and zinc, 185 per cent. The composite price of these six metals had declined to 12.72 cents on July 1, 1914, against 33.75 cents on May 15, 1917, or an increase of 265 per cent. Never before in the history of the metal industry have prices soared to such heights in such a comparatively short time, and the indications are that the peaks have not yet been attained.

The non-ferrous metals that are most serviceable include aluminum, antimony, copper, lead, tin and zinc, and nickel follows in the order named. Without these metals, our present complex civilization would be impossible and their importance scarcely is secondary to that of food-stuffs, iron and coal. The available supply of these metals is steadily diminishing since they are lost by volatilization in melting operations and by attrition in service. It is conceivable, therefore, that a time may come when the resources of these metals will be exhausted, and while this may appear to be far-distant, nevertheless it is essential that this should be postponed as far as possible by the adoption of methods which will tend to eliminate waste.

The accompanying table contains the highest and lowest prices attained by these metals from 1900 to April of this



HOW THE PRICES OF NON-FERROUS METALS HAVE CLIMBED DURING THE WAR PERIOD, WITH A GRAPH OF THE COMPOSITE PRICES OF SIX METALS, MAY 15, THIS YEAR AND JULY 1, 1914

year. It will be noted that the price of aluminum was fairly constant until 1906 when a sharp advance occurred. This was maintained during the following two years, after which an era of comparatively low prices existed until the present war boom set in. Antimony likewise enjoyed a period of prosperity from 1905 to 1907, with a period of depression for four years, after which it recovered with a sudden jump to the present abnormal basis. Copper, lead, tin and zinc each have a history similar to aluminum and antimony, as the same causes that operate to affect the price of one metal of the non-ferrous group affects them all, and while the present level of values cannot be considered to be permanent, it is doubtful whether there ever will be a return to the comparatively low prices of former years.

In the following table, non-ferrous metal prices prevailing on July 1, 1914, and May 15, 1917, are compared and the per cent of increase is noted. The composite prices of these six metals also are included:

Comparison of Non-Ferrous Metal Prices, July 1, 1914 and May 15, 1917.

	July 1, 1914. cents.	May 15, 1917. cents.	Per cent increase.
Aluminum	17.25	62.00	360
Antimony	6.75	25.00	370
Copper	13.25	31.00	234
Lead	3.80	9.50	250
Tin	30.30	65.75	217
Zinc	5.00	9.25	185
Composite Prices of Six Metals.			
	12.72	33.75	265

Aluminum

Aluminum is the first metal on our list to receive consideration from a conservation standpoint. There is no need for the sparing use of this metal for fear of exhaustion of supply, since cost is the all-important factor in this case. Aluminum is one of the most abundant elements on the surface of the earth; in combination with oxygen and silicon, it occurs in enormous quantities in rocks, soils and common minerals. It is destined to play an important part in the history of the world, since by its extended use the resources of all other non-ferrous metals can be husbanded. Its production will increase until it ranks with iron and steel and its price will decline until it can be applied to uses undreamed of now. At present aluminum is being extracted only from its richest ores, thus paralleling the history of most other metals, and its production is hampered by the fact that the deposits of these ores are limited and can be controlled to better advantage than would be the case if aluminum were being obtained from kaolin, or other clays. The source of the aluminum, utilized at present, is bauxite which has to undergo a process of purification before the metal can be obtained therefrom. This is due to the fact that the reduced aluminum otherwise would contain all the impurities that existed in the material from which it was extracted; therefore, if the bauxite were not first purified, the aluminum obtained therefrom would be an alloy of aluminum, iron and silicon, in varying proportions. Such an alloy would be of no use commercially because there is no method of separating the aluminum from the iron and silicon. The purification of the raw material is a considerable item of expense connected with the production of aluminum, therefore, it is highly desirable that improved methods be discovered and utilized, otherwise it is not probable that the price of this metal ever will decline much below 20 cents per pound. The production of aluminum in the future probably will be closely associated with the fixation of atmospheric nitrogen. The Serpek process, utilized to a limited extent, purifies bauxite by first converting it into aluminum nitride, from which nitrogen products are obtained, and finally, pure alumina which is the starting point of pure aluminum.

Smelting Processes

Unfortunately this process also utilizes the richest ore of aluminum, and as this method of purification, even with the advantage of the nitrogen by-products is more costly than the usual method, it has not been adopted generally. Another process, however, appears promising which utilizes kaolins to first make a siliceous aluminum. It then passes the alloy through a process of purification that separates the silicon as metal, and the aluminum as nitride, and from the latter nitrogen products and pure alumina are obtained, the last product being pure aluminum. It will be noted, therefore, that the day of cheap aluminum undoubtedly is coming, but in the meantime we are concerned more with its present cost and are interested in methods of conserving the metal, by practicing economies whenever this is possible.

There is no great opportunity of conserving aluminum by re-designing patterns, as the metal or its alloys is not used in castings where electrical conductivity is essential, as in the case of copper where it frequently happens that the sectional area of the castings is much greater than strength would demand, or what would be required if the conductivity of the copper were not injuriously affected by the impurities introduced by casting methods.

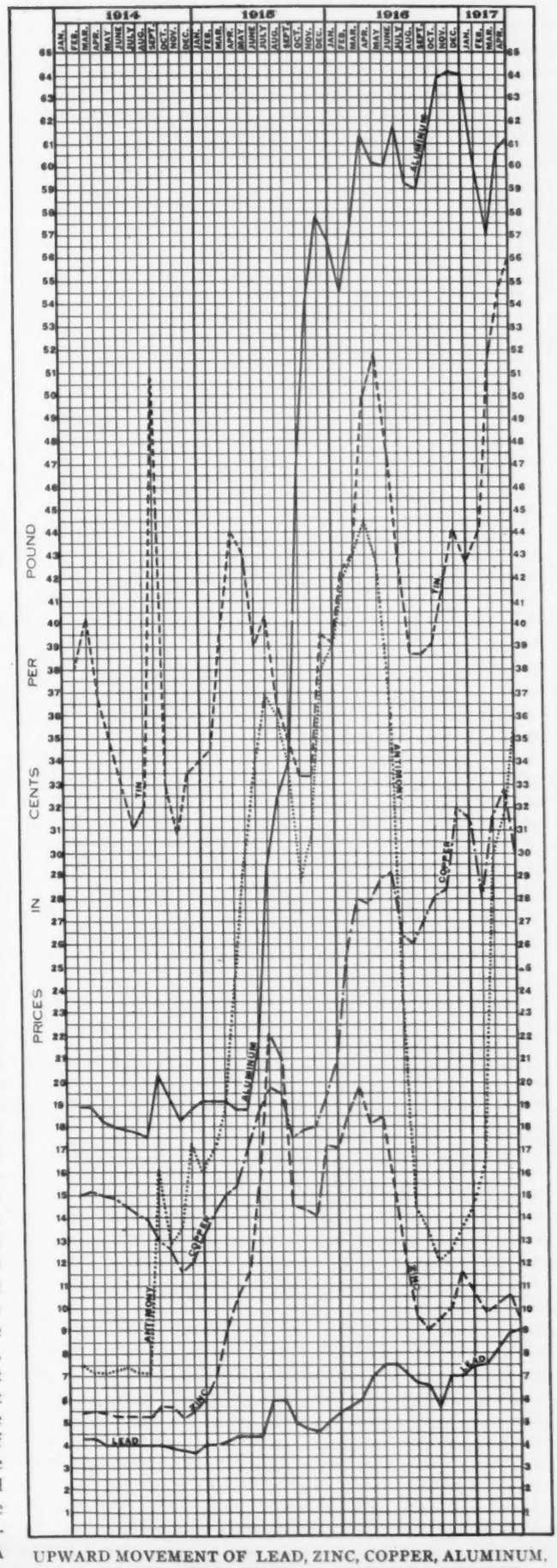
The point where the greatest saving of aluminum can be effected is in the operation of melting the metal or its alloys, and especially is this the case in melting scrap metals, turnings or other forms of finely divided material. If this operation is not conducted skill-

High and Low Prices of Non-Ferrous Metals, 1900 to April, 1917, in Cents Per Pound

Year.	Aluminum. High.	Aluminum. Low.	Antimony. High.	Antimony. Low.	Copper. High.	Copper. Low.	Lead. High.	Lead. Low.	Tin. High.	Tin. Low.	Zinc. High.	Zinc. Low.
1900	33.00	33.00	11.00	9.75	17.25	16.00	4.80	3.50	32.50	25.25	4.75	3.50
1901	33.00	33.00	10.62	10.12	17.25	15.00	4.40	4.25	28.75	24.75	4.80	3.75
1902	33.00	33.00	10.50	9.00	14.50	12.12	4.00	4.00	30.50	24.75	5.50	4.00
1903	33.00	33.00	9.00	7.00	15.25	12.00	4.75	4.00	30.50	26.00	6.25	4.75
1904	33.00	33.00	9.60	7.00	15.25	12.25	4.50	4.12	29.80	26.50	6.00	4.75
1905	33.00	33.00	16.40	8.10	19.25	15.00	5.50	4.50	36.50	29.80	6.25	5.25
1906	38.00	33.00	26.90	14.50	24.50	18.50	6.00	5.50	43.75	36.50	7.00	6.00
1907	48.00	38.00	26.00	9.50	26.75	13.50	6.12	4.00	43.60	28.00	7.25	4.50
1908	38.00	25.00	9.60	8.10	14.50	12.75	5.25	3.75	32.25	27.75	5.25	4.25
1909	25.00	22.50	8.75	8.00	14.50	12.80	4.75	4.00	33.50	28.50	6.50	4.75
1910	24.00	22.00	8.75	7.75	14.00	13.12	5.00	4.50	39.50	32.50	6.25	5.25
1911	22.50	18.75	9.60	7.90	14.12½	12.25	4.62	4.50	46.50	38.75	6.75	5.50
1912	27.00	18.75	10.55	7.10	17.75	14.00	5.25	4.12	50.50	42.75	7.75	6.50
1913	27.00	19.00	10.00	7.50	17.50	14.75	5.00	4.25	50.75	37.50	7.25	5.00
1914	20.50	17.50	17.40	7.10	15.00	11.36	4.25	3.75	50.75	30.50	6.00	5.00
1915	60.00	19.00	41.00	16.50	21.50	13.00	6.00	4.00	49.00	33.00	22.62	6.00
1916	66.00	55.00	44.50	11.25	34.50	23.75	8.00	5.90	56.00	38.40	22.00	8.75
High and Low Prices by Months, 1917												
January	62.00	57.00	26.50	14.20	29.60	26.70	8.00	7.50	46.00	42.60	10.90	9.00
February	58.00	56.00	32.50	25.00	34.00	28.50	8.50	8.00	56.00	49.20	10.70	9.50
March	61.50	58.00	35.00	28.50	33.33	31.50	9.00	8.50	56.50	51.80	10.80	10.50
April	62.00	60.50	36.00	35.00	31.50	28.00	9.00	9.00	59.00	54.30	10.50	8.80

fully the loss will be enormous, while with intelligent handling it is no greater than in the case of other metals. In running down sheet material that is more or less corroded, the loss will be higher than in the use of clean turnings, because the decomposed metal cannot be recovered, but goes to the dross. In melting, the same general methods should be applied to all forms of scrap aluminum, and therefore, a description of a satisfactory method of melting turnings will be given to illustrate the point.

In melting aluminum turnings it is not advisable to use such fluxes as cryolite or calcium fluoride, and as it is highly desirable that the metal be kept away from contact with carbon, the crucible should be given an internal coating of fireclay. The fireclay should be of good grade, passed dry through a fine screen and mixed with water containing silicate of soda. It can be painted onto the crucible in the form of a creamy wash after which it must be allowed to dry slowly to avoid blistering the wash. The importance of keeping the aluminum away from carbon cannot be emphasized too strongly. The crucible should be allowed to reach a red heat before the aulminum turnings are charged. In charging, it is filled with the turnings, after which the furnace should be closed until a melting heat is attained, and after the lapse of sufficient time to allow this stage to be reached, the furnace should be opened and the metal stirred. It will be found to be liquid, but mushy, and additional turnings should be charged. This process should be repeated until the crucible is filled with metal to a point about 1½ inches below the top. The temperature of the metal sholud be below red, and there is little doubt but that it will be mushy, not fluid. This is the time to use zinc chloride; a small piece of this fused material, about the size of a walnut, is tossed onto the surface of the molten aluminum and the latter is stirred vigirously. A reaction will occur, leaving



UPWARD MOVEMENT OF LEAD, ZINC, COPPER, ALUMINUM, TIN AND ANTIMONY, SINCE 1913, CLEARLY INDICATED

the metal fluid and the dross will rise to the top. Concentrate attention on the dross and skim it off immediately, either by removing the crucible and skimming in the usual manner, or while the metal is in the furnace. This can be accomplished by using a wide piece of band iron suitably curved at the end. The metal is then ingoted, and if the turnings were reasonably clean and the operation carefully conducted, a recovery of 95 per cent of alminum, or more should be obtained.

After the use of zinc chloride, if the dross is left on the metal, the nitride will begin to form, first as an incandescent area next to the crucible which will spread rapidly and take up the metal to form nitride and oxide until the crucible is filled with an intensely heated, glowing mass of the two. This means a heavy loss of aluminum, in fact all the aluminum can be lost in this manner by occasionally skimming off the dross to expose the metal which will be heated strongly by the reaction, and as quick as the air gets to the hot metal a further conversion will occur. The reason why carbon should be excluded is that it strongly favors this reaction thereby causing loss of aluminum. The zinc chloride acts as a catalyzer converting aluminum to nitride and oxide; therefore, it is imperative that it be used sparingly and after having been added, its effect should be neutralized by the removal of the dross before it reaches a temperature favorable to further change. Aluminum never should be melted in a furnace in which the products of combustion are driven by a blast so as to converge and pass through an opening centered over the crucible. As the metal is melted without a cover, the rapidly moving and highly heated gases are in excellent condition for entering into reactions with this chemically active metal.

Antimony never attracted much attention before the recent era of high prices and no attempts were made to substitute other metals for it until the war placed it in

the limelight; then much research work was undertaken to discover substitutes. There is no substitute for antimony, as this metal fills a niche of its own. As a hardening agent for lead it is unexcelled and no other element can take its place. The alkali and alkaline earth metals have been tried for the latter purpose, but are objectionable because they are not permanent. Sodium, calcium, strontium and barium, all alloy with lead and harden it, and relatively small percentages have a profound effect in this way, but sodium, when used in as small quantities as 1 per cent with lead promotes the formation of an external coating of sodium hydroxide, and with higher percentages the alloy is deliquescent when exposed to the atmosphere. With still higher percentages of sodium, lead forms the alloy known as hydrone, which has to be kept in air-tight receptacles, and finds application as a means of obtaining hydrogen, owing to the property it possesses of decomposing water. Calcium, and its sister metals of the alkaline earths, when alloyed with lead, form alloys more stable than is the case with sodium, but they will not stand remelting without loss of the hardening element; consequently, after remelting a few times, and even in one melt if the lead is overheated, the hardening element has disappeared and the lead arrives at the stage from which it started, namely, pure lead. From a conservation standpoint there are few suggestions that may be offered regarding antimony. We will have to use it while we have it and when the supply is exhausted, if this ever happens, we will have to try to get along without it.

Copper is one of the metals on which conservation should be practiced as we are now producing and using more than ever before. In fact it is being used prodigally, even wastefully in spite of its cost, and there is not a shadow of a doubt but that great economy in the use of this metal would result from improved methods of manufacture if applied judiciously to the making of castings for electrical purposes.

Casting Copper

Copper always has been regarded as an obstinate metal to cast and in this property it differs greatly from some of its alloys. A few copper alloys retain all of the bad features of the parent metal with a few added troubles of their own, as for instance, aluminum-bronze and manganese-bronze, but the common alloys are quite easy to cast. The great difficulty encountered in making copper castings is to overcome porosity as the pure metal cannot be poured in a sand mold with the production of sound castings by a simple melting process no matter how the latter may be carried out. For instance, copper has been melted in a muffle, heated electrically and carefully sealed after an atmosphere of carbon monoxide had been created in the muffle by means of a little charcoal packed between the sides of the crucible and the muffle. Under these conditions several heats of 10 kilograms each were made with identical results. In each case the surface of the molten copper was protected by a covering of fine charcoal and this cover was retained while the crucible was being transferred from the furnace to the molds. In each case the resulting castings were porous, although not nearly so honeycombed as they would have been if the copper had been melted in fuel-fired furnace. The holes in the electrically-melted metal were so fine they could scarcely be detected by the naked eye, and when the copper was poured, the pouring head and risers bulged so slightly it was scarcely noticeable. The castings were nearly sound, but fell short of perfection, and therefore, were unsatisfactory. The experiment proved that copper cannot be melted and cast into sound castings without some treatment calculated to remove the absorbed gases. In the case just outlined a minute amount of any suitable deoxidizing agent would have insured sound castings. These, because of the small amount of impurity added to attain this end, would have possessed the property of high electrical conductivity. Such a method of melting, therefore, possesses important advantages over the usual processes.

Avoiding Porosity

When copper is melted in a combustion furnace, regardless of how carefully it may be protected from the gases that are formed therein, it is always necessary to add some element, such as silicon, zinc, magnesium or phosphorous to remove the gases that cause porosity, but the difficulty is to add just the proper amount to accomplish the desired result and leave only a trace of the impurity in the copper. This difficulty is so great that it is impractical to attempt to attain this result and at the same time adhere to the ordinary methods of melting and casting the copper. There is no way of determining exactly how much oxide, oxygen, sulphur or gaseous bodies the copper may contain as the amount of these undesirable impurities will vary with every melt. It is necessary, therefore, to add an excess of the deoxidizing agent with the result that the metal is so impure that its electrical conductivity may be reduced to 60 per cent, or even 30 per cent of that of pure copper.

Assuming for the purposes of illustration that the conductivity of the copper is reduced to 50 per cent of that of pure copper, it readily will be realized what effect this would have on any electrical installation in which copper castings were used as conductors. It would require double the amount of copper theoretically necessary to carry the load, and in order to carry the extra and useless weight of copper required, the apparatus to which it was attached would have to be built twice as strong as necessary.

Practical Methods of Casting

The subject of deoxidizers and their application to copper for casting purposes is most complex and cannot be treated fully here, but will be discussed in a subsequent article. The discovery and utilization of practical methods of casting pure copper would effect a great saving in the use of this indispensable red metal. It likewise would mean an important saving in the cost of electrical installations requiring the use of such castings and therefore, is desirable also from a monetary point of view. The demand for improvements in methods of casting copper will come, of course, from users who require such parts, but it should be pointed out that if these consumers expect to derive all the benefits from these savings, there will be no inducement to foundrymen to apply improved methods.

Outside of the electrical field copper castings are used because of their special properties, such as for blast and other furnace tuyeres where copper is used on account of its high heat conducting qualities. For this line of work no saving of metal by paring the patterns is possible, and therefore, the field for improvement is too meager to be a subject for consideration.

When we turn to the alloys of copper we find that notable economies have already been effected by the substitution of iron and steel for brass. This has been rendered possible by the application of enamels and so-called enamel paints to iron and steel surfaces thereby producing a satisfactory substitute for brass where the latter is used solely for its ornamental value. However, the competition of iron and steel with brass has made no perceptible impression on the latter industry, and probably has passed without notice except by those directly interested. New avenues for the sale of brass, bronze and copper castings have been developed continually in the past decade. The automobile and motor truck have created an immense demand for non-ferrous metal castings. Electric welding processes have stimulated the demand for copper castings, and the same is true of the extended application of the electric furnace in the operation of which large quantities of copper and bronze water-cooled electrode holders and cast copper terminals are used.

Another promising industry, from the point of view of the brass founder, has been created by the advent of the diesel engine, in the construction of which a

large amount of non-ferrous metals is required.

The demand created by the automobile, the diesel engine and other modern inventions is more particularly for castings of definite chemical composition and high physical properties. The blunderbuss method of making alloyed metals, which consists of throwing into a crucible, or open-flame furnace a little of this, that, and the other kind of scrap, melting and stirring it together, with an eye to careful economy of tin, and open-hearted generosity in regard to lead and zinc, will not suffice in these latter-day industries. The metal must be made to conform to a specified formula and test bars for large sections, must be attached to the castings. The castings used on automobiles generally are small and consist largely of alloys suitable for bearing purposes. The worm gears for some auto trucks are desirable castings to make as they may weigh from 60 to nearly 100 pounds. The alloy used is phosphor-bronze, containing substantially 11 per cent of tin with sufficient phosphorous to make the alloy machine easily. These castings must be made in chills to prevent segregation of the various copper-tin compounds formed as a result of slow cooling, and to reduce the size of the crystals by allowing no time for growth. The gears are merely rings with straight sides, and the teeth are cut by special machines being shaped to fit the circle of the worm on their outer edge.

Rolling Gears

The designing engineer could save considerable metal on each ring by having them cast with a groove on the periphery instead of being straight-sided. Another and more material economy could be instituted by rolling-in the teeth of the gears instead of having them cut by machine. In this case it would be necessary to change the alloy, as phosphor-bronze is too brittle to roll. Manganese bronze would be suitable for the purpose, and aluminum-bronze also could be used, although from the bearing point of view there is little choice between aluminum or manganese-bronze.

Castings of the copper-tin alloys and manganese-bronze are used in the construction of diesel engines, and sometimes great difficulty is experienced in getting the desired physical qualities. The part of his work that causes the most anxiety to the brass founder, as it is responsible for the most failures, is melting the metals.

When castings of the copper-tin alloys are broken cold and the appearance of the fracture suggests the idea that a quantity of red and black pepper has been mixed in the metal, the fault should not be attributed to particular mixture employed, but to the mixer and melter.

To cast high grade copper alloys successfully requires as much skill as is demanded in any branch of the foundry industry, and all failures are due to inefficiency. When test bars fail, someone has blundered and the fractures of the bars furnish all the evidence required. In the conservation of metals, ignorance and inefficiency have no place, because with such factors to contend with, conservation is impossible. This applies also to the production of pure copper castings. The lack of the knowledge necessary to make castings of high electrical conductivity results in a greatly increased consumption of copper; in the case of alloys, inefficiency or the lack of the knowledge required to make the alloys in a manner that will obtain them free of all non-metallic impurities results also in a greatly increased consumption of metal, because alloys unskillfully made will be so much lower in ultimate strength and elongation than they should be, that castings must be made of larger section to obtain the required strength. A casting made to specifications and containing 10 per cent tin, with a little zinc and lead can be made to develop from 50,000 to 60,000 pounds tensile strength and from 40 to 50 per cent elongation. But such results could never be expected from the present state of the art; more probably the test bars would show a little over 30,000 pounds tensile, with from 6 to 10 per cent elongation. It is a fact, well-known in a general way, that specifications requiring a tensile strength of 35,000 pounds per square inch, with 15 per cent elongation are none too easy to meet in the average brass foundry. Much higher specifications than these should be complied with easily, and if they could be, as a matter of regular business, the patterns could be shaved accordingly, resulting in a saving of materials. The founder, of course, would sell less brass, but if a more equitable selling arrangement were adopted, he would realize a better profit than at present, because he would be better paid for the work accomplished, lose fewer castings and have less money tied up in metals.

Making Manganese Bronze

Great improvements also can be made in methods of producing manganese bronze. Foundrymen generally pretend to know how to make this alloy, and each has his own particular practice. The result is that manganese-bronze is supposed to be a difficult alloy to make, when in reality it is one of the most simple alloys to compound, when made by the use of a low melting point hardener containing iron in an easily soluble form, instead of being made by the use of the antiquated *steel alloy* with its erratic results. The standardizing of methods for making manganese bronze would bring important results from a conservation standpoint, since it would permit the alloy to be made of any quality desired, within a range of 60,000 pounds per square inch tensile, and 50 per cent elongation, to 90,000 pounds tensile and not less than 25 per cent elongation. In concluding the subject of copper alloys, it should be stated again that a standard method of making manganese-bronze is to be desired as there would result fewer failures entailing losses to the foundryman, and more dependable results would be attained by the engineer.

From a conservation point of view, there is not much to be said for lead as it is the cheapest metal used in the practice of making brass castings, and the tendency is to add as much to the alloys as the purchaser will stand for. It is a valuable constituent of alloys used for bearing purposes and in this case fills a legitimate function. Lead also is used to made alloys more machinable and could not be dispensed with for this purpose. The tendency, therefore, is toward an increased consumption of this metal.

Tin Economy

As tin is the most expensive metal employed in brass foundry practice, it is seldom used extravagantly, although it frequently happens that it is used inadvisedly. The foundryman usually makes it a point to economize on tin, in order to keep the cost of the mixtures to the point where he can do business and exist. There are numerous ways in which tin can be used economically; the most important consideration is to know when, how, and where to use it; in other words, it is the ability to select the right alloy for any stated purpose that counts as one of the greatest assets to the successful conduct of a brass foundry, whether large or small. It is an extravagance to put an alloy containing 10 per cent tin into a casting where an alloy with a content of 2 per cent tin would serve the purpose better, and yet this is frequently done. Small castings that are to be finished rapidly on monitor lathes do not require much tin; otherwise, the machine operator will complain that they are too *hard*. The same complaint will be voiced if the metal is too tough, due to low lead content. In making red brass low in tin, the practice should be adopted of adding the tin in the form of scrap, and to this end a careful study of the scrap metal piles will be well repaid. The pieces of scrap that experience suggests are likely to be rich in tin should be picked out and as it is not possible to get an analysis of such mixed material unless it is all melted down into ingots, it is a good idea to make a mental appraisement of the tin content of the selected scrap.

An old foundryman can do this by intuition, but a beginner would be at a

loss as how to proceed. In the latter case, remember that one is never too old to learn, and commence a course of education as follows: Have a few alloys carefully made, and cast into bars 1 inch square by 6 inches long, in sand molds. Take the bars, when cold, and nick them ⅛-inch deep across one side in the center, and then break the bars. Next saw off one of the sections with a fractured surface, and place it in a corked, clear glass, wide-mouthed bottle and label the bottle in order to be able to identify the specimen. The reason for placing the samples in a bottle is that they would oxidize and change if exposed to the air and would soon become worthless for purposes of comparison. Make a number of these alloys with different percentages of tin, lead and zinc, corresponding to the alloys most commonly used; also bottle samples of the alloys that are being made regularly. The composition of any scrap can be estimated approximately, after a little practice, by casting it into a bar from the pattern used for the samples, and comparing the fracture with those of the standards, until one is found that resembles the scrap closely. Large pieces of scrap can be broken and compared with the samples without being melted.

Selection of Small Scrap

Small scrap is best compared by casting a test bar from a heat so selected from the pile as to be fairly representative. The scrap can then be used intelligently, to make red brass and other alloys, and the results can be checked by running a bar when casting the first heat, breaking it and comparing the fracture with the standard samples of that particular alloy. Turnings can be utilized in this manner just as well as scrap brass. It is important to know how to use scrap brass of all kinds in an intelligent manner, as by this knowledge it is possible to practice great economies in use of tin. Old metal remelted properly is as good as that made from virgin metals, and in many cases better, as it has been more thoroughly mixed by being melted several times. When remelted metal is consistently found to be inferior to new metal of the same composition, this is an indication that those responsible for the melting are not efficient, and in this connection it may be remarked that it is short-sighted policy to place the blame entirely on the man who attends the fires; get after the ***man higher up***.

In a well-managed brass foundry very little return metal is allowed to accumulate in the bins of the metal room; when received, it will be immediately turned over, by being converted into castings of the same composition or into other alloys. The handling of metals to the best advantage is of vital importance to the brass founder as the competition is keen and the industry an old one; we are told that Tubal Cain, far back in Biblical times was the first brass founder and whether this is true or not, sufficient time has elapsed since brass founding became a business for it to be generally and quite thoroughly understood as far as the production of ordinary castings is concerned. There is no opportunity, therefore, for exorbitant profits and if economy is not practiced in the conduct of the business, sooner or later, depending upon the amount of the capital invested and available for the purchase of metals, the business will fail and become merely a memory.

Conservation of Zinc

The remarks concerning tin apply similarly to zinc, although this metal is not usually classed as an expensive one. It becomes expensive when wastefully used. The conservation of zinc is an important subject to the brass founder, as a considerable amount of metal loss can be traced to the volatilization of the zinc in melting the alloys. This usually figures out as so much brass loss; therefore, it is important to keep it as low as possible. This is another function of the melting end of the business, another index to the importance of this operation. Zinc is volatilized by ***holding*** metal in the furnaces after it has reached the pouring temperature, and while this practice occasionally may be unavoidable, it should not be allowed to become the standard under any consideration. The practice is usually due to the metal getting ahead of the molders, in other words, bad judgment is used in estimating the time necessary to make the molds. It is always better to let the molds wait for the metal, so that the latter can be removed from the fire when ready. Zinc loss is also promoted by the failure to use suitable fluxes to cover the metal. Charcoal as a cover is now universally employed, but is insufficient alone, and should be supplemented by one of the excellent fluxes now on the market. A flux that melts to form an air-tight cover over the molten metal in the furnace is a valuable adjunct to the melter and one which, when dispensed with, results in loss in many ways. It is advisable to always use something in addition to charcoal, but the latter should not be discontinued.

When small amounts of zinc are to be added to alloys, it is always economical to add it in the form of yellow brass of known composition, such as sheet brass clippings, etc.; this is due to the fact that the sudden volatilization of zinc, which occurs when it is added to hot molten copper or brass in the metallic form, is thereby avoided.

When making high-zinc alloys, such as manganese-bronze, it is not possible to avoid all volatilization of the zinc, but it can be controlled and kept at a minimum by skillful management, such as cooling down at intervals, or just before pouring, by the addition of reserve pieces of metal of the same composition.

Molding Sand Gets Right of Way to Oct. 15

Instructions have been issued by the commission on a car service of the council of national defense to the railroads of the country to include molding and furnace bottom sand in the list of commodities which are to be given preferred car movements. This action was vitally necessary to afford a supply of sand for the next 12 months, but the preferred movement of this material is to be confined only to the ensuing six months. Ample supply of this sand, it was pointed out, to the commission, is necessary to make possible the production of steel and iron products which will be required in large quantities in connection with the national defense. The foundries of the country have been operating on a hand-to-mouth basis because of a lack of rolling stock to move the sand. This has resulted in some foundries being closed down as well as a shortage of castings of all kinds.

The foregoing facts were laid before the commission by a committee representing the Ohio Sand Traffic Association. The committee was composed of President F. E. Gordon, Conneaut, O.; E. M. Ayers, Zanesville, O., and E. E. Klooz, Youngstown, O. The committee called upon the commission in Washington and was so successful in conveying to the commission the importance of the question under discussion that the latter body arranged at once to issue an order giving preferred car movements to molding and furnace bottom sand.

Members of the Ohio Sand Traffic Association include the following companies, all of which, except the Garden City Co., Chicago, have plants in Ohio: Gordon Sand Co., Conneaut; Portage Silica Co., Youngstown; Interstate Sand Co., Zanesville; Superior Sand Co., Cleveland; Standard Sand & Machine Co., Cleveland; Eberhard Co., Massillon; Oliver Silica Sand Co., Massillon; Newman Silica Sand Co., Massillon; Massillon Sand & Stone Co., Massillon; Beach City Silica Sand Co., Beach City; Keener Sand & Clay Co., Columbus; New Lexington Sand Co., New Lexington; Jones Sand Co., Columbus; Burton Townsend Co., Zanesville; Ayers Mineral Co., Zanesville; Garden City Sand Co., Chicago; Franklin Industrial Co., Massillon; Geauga Lake Silica Sand Co., Cleveland; National Sand & Stone Co., Niles; Summit Silica Co., Barberton, and the Millwood White Sand Co., Howard.

Fig. 1—Molding Floor in the Foundry of the Power Mfg. Co. The Crane is Operated from the Floor by Means of Ropes

How It is Done in An Ohio Shop

EXPERIENCED foundrymen know that the size of a foundry is not a reliable measure of the standard of its equipment or the efficiency of its operating methods. Ordinarily, a large casting plant of modern design and with the latest type of equipment attracts considerable attention because of the spectacular nature of its intricate system of conveying machinery, cranes, molding machines, sand-blast and cleaning room equipment, etc. The very existence of expensive labor-saving apparatus suggests efficiency, although the implication is not always justified.

In the smaller plant, the evidences of careful planning and smooth operation are not so conspicuous. The margin between profit and loss is so narrow that the line between necessity and luxury must be finely drawn in purchasing equipment. Moreover, operating expenses must be kept within a well defined limit, and to accomplish this successfully, the foundryman must have reliable data to warn him when the costs threaten to leap out of bounds.

Simple Cost System

Methods that make for economy, together with a simple system of cost accounting, lend interest to the foundry of the Power Mfg. Co., Marion, O., manufacturer of fuel-oil engines. The business is the development of the early experiments of J. M. Primm, who in 1902 made his first successful engine in a modest factory in Van Buren, Ind. In 1907, when it became necessary to seek larger quarters, a plant consisting of two medium sized factory buildings was secured at Lima, O. In 1915, this plant was partially destroyed by fire.

The new plant, which is at Marion, O., consists of one large factory building and two auxiliary structures. The main building is 500 x 80 feet, and contains the machine shop and foundry. The machine shop occupies the south end and the foundry, 80 x 200 feet, is in the north end of this building. A bay, 40 feet high, traverses the entire length of the main building and is flanked on either side by a 20-foot bay. The side walls are of 8-inch brick construction, on which are mounted continuous sections of steel sash. The roof is of composition material laid on 1⅛-inch

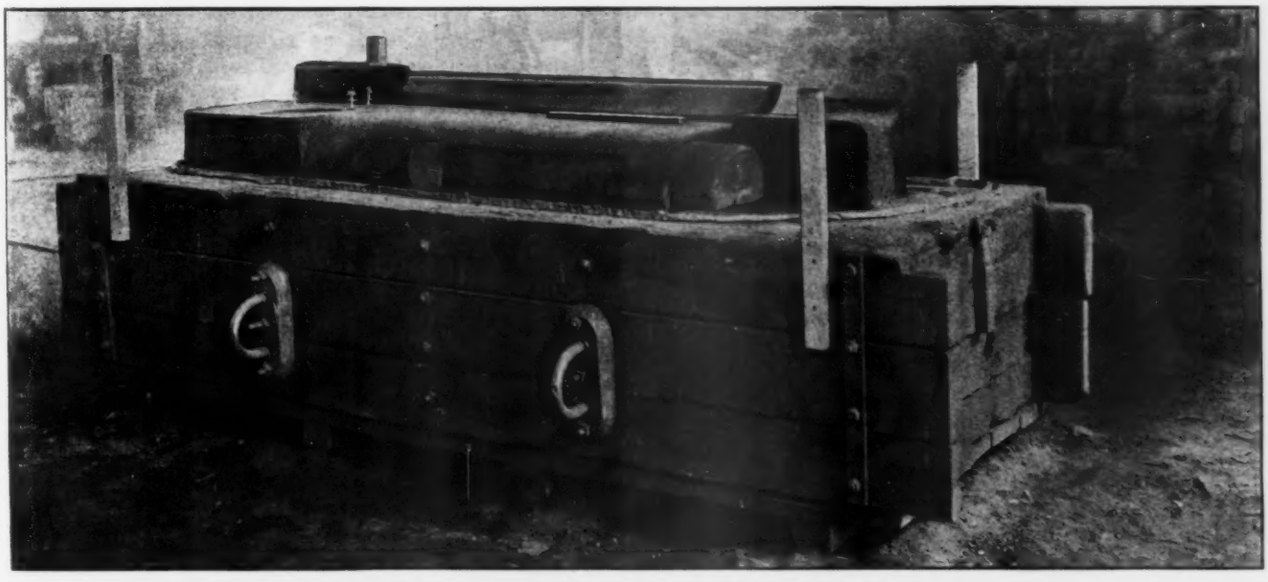


FIG. 2—DRAG OF MOLD FOR BED-PLATE OF 100-HORSEPOWER FUEL OIL ENGINE

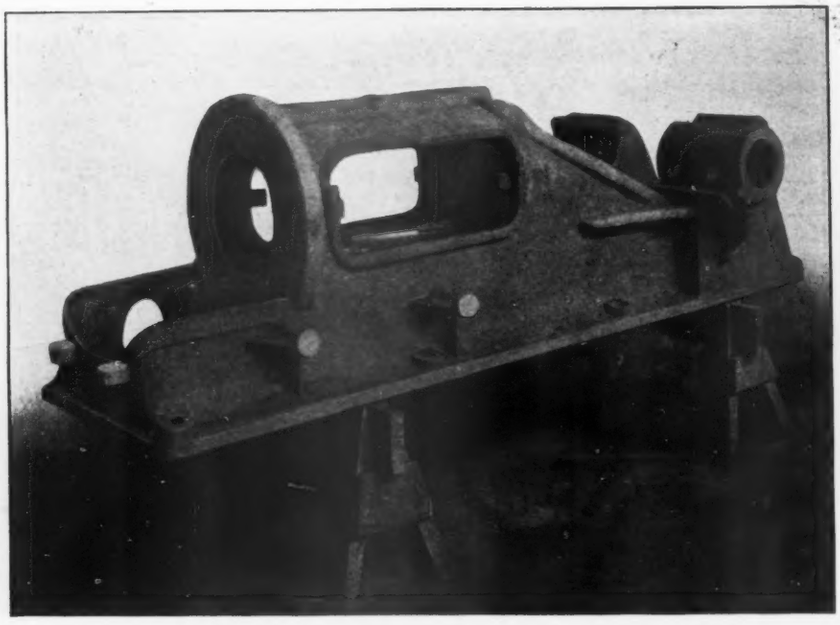


FIG. 3—BED-PLATE CASTING READY FOR THE CHIPPING HAMMERS

tongued and grooved sheeting. The floor of the machine shop is concrete.

The sole product of the Power Mfg. Co. consists of fuel oil engines which are used for hoists, mines, cotton mills, and in all kinds of work where the cost of steam outfits is prohibitive. At the present time, the foundry is engaged in the production of castings for engines, but in the future, it is thought that some jobbing work for outside concerns will be done. The castings made in the foundry consist principally of bed-plates, pistons, cylinders, flywheels, bearing caps and other smaller castings used in the plant.

Fig. 2, which shows the mold of a bed-plate for a 100-horsepower fuel oil engine, is typical of the work done in this shop. It will be noted that the pattern is embedded in the sand on its side and that the mold is parted in the center of the lug to which the cylinder is bolted. Although at present a split pattern is used, a solid pattern has been devised for this purpose. Although more cores will be required with the new patterns, it is believed that less trouble will be experienced in casting. As indicated in Fig. 2, the important part of the mold consists of the intricate cores. On account of the number of large cores required, the preparation of the mold for the bed-plate of a fuel oil engine requires two days. For this reason it is convenient to pour on every second day, thus allowing two days for the accumulation of a sufficient number of molds to warrant making a large heat. The finished bed-plate is shown in Fig. 3. In this illustration the casting is on horses ready for cleaning.

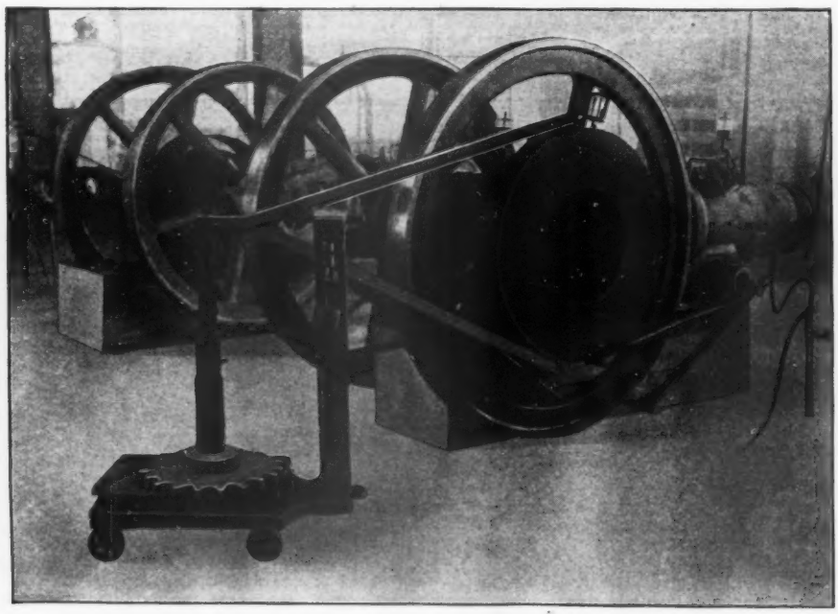


FIG. 4—FINISHED ENGINES ON THE TESTING RACKS—THE FLYWHEELS, BED-PLATES, CYLINDERS, CYLINDER HEADS, PISTONS, BEARING CAPS AND SEVERAL SMALLER PARTS ARE THE PRODUCT OF THE FOUNDRY

Handling Fuel and Iron

The cupolas, sand bins, core ovens, core room and pattern shop are situated at the east side of the foundry. The melting equipment consists of two cupolas, one 33 inches and the other 42 inches, inside diameter. At the present time, the pig iron, coke, etc., is brought from the storage yard on hand cars, run onto an elevator, lifted to the charging platform and there weighed and charged. A new system for handling the raw material, which will soon go into effect, involves the employment of an industrial railroad running alongside the storage bins for iron, coke, etc. The materials will be conveyed by cars on the tracks to a point near the elevators and there the charges will be made upon steel platforms suspended from automatic scales. When the proper amount of material has been placed on a platform, it will be dropped onto an elevated truck and run onto the elevator. The truck can be removed, and the platform lifted to the charging floor, where another elevated truck will be pushed under the platform. The charge on the platform then can be moved to a convenient place to await the time when it is to be used, or can be immediately placed in the cupolas, as required. The elevator was built by the Cincinnati Elevator Co., Cincinnati, and is operated by a clutch attached to a lineshaft driven by a 30-horsepower Westinghouse motor running at 900 revolutions per minute. This motor also drives a blower for the cupolas made by the P. H. & F. M. Roots Co., Connersville, Ind.

On account of the comparatively limited demands on the crane, it is not economical to devote the time of one man to operating this equipment which serves the main bay and is controlled from the molding floor by six ropes operating controllers hung on the lower side of the crane bridge. This system of control enables any workman to accurately direct the movement of the crane bridge, the overhead trolley or the hook by means of the ropes. The crane, furnished by the Euclid Crane & Hoist Co., Euclid, O., is used for handling flasks, cores and castings

and in distributing metal to the molds. When cores are being lowered in molds, slings of 3-inch fiber belting are used. It is believed that fiber is better than leather for this purpose, as it is more pliable. The small machine bolts used to join the ends of the sling can be easily removed to release the core after it has been lowered onto the mold.

The methods employed in molding the various castings in this foundry are not unusual. One feature of the molding practice, however, will prove of interest. It is essential that the iron in all castings be of the best possible quality. To protect the company against loss from poor castings, an ingenious skim-gate is used. This gate, which was developed by the foundry foreman, consists of a round disc perforated with holes about 5/16-inch in diameter. The edges of the disc are tapered to fit the tapered holes of the gate in the flask. Fig. 5 illustrates how the skim-gates are made. The piece, *A*, is a master gage from which the core boxes, *B*, are made. Piece *A* is embedded in packed sand with the cup side down. Sand is packed around the outside and slicked off flush with the top. Then the staple, *C*, one leg of which is longer than the other, is inserted in the holes of the master gage. The short leg of the staple is just long enough to allow the long leg to enter the sand to a point flush with the outer rim on the other side of the master gage. After the holes have been punched in the sand, the mold is finished and poured, the resulting casting being a core box in which the skim-gate may be made. In making the gates, which are similar to that shown at *D*, core sand is packed in the core box, *B*, the extra sand is slicked off and the core box is then inverted on a flat board. After slightly tapping the core box, it may be lifted from the sand, and after the sand has been properly baked the skim-gate is finished. The rough edges or imperfect holes may be smoothed-up by merely rubbing the pieces of two gates together. The pouring basin is built-up around a post, *E*, which is tapered to fit the gate. In pouring, the perforated disc holds the metal back, allowing the dirt to rise to the top and permitting the clean metal to drop through the holes into the mold.

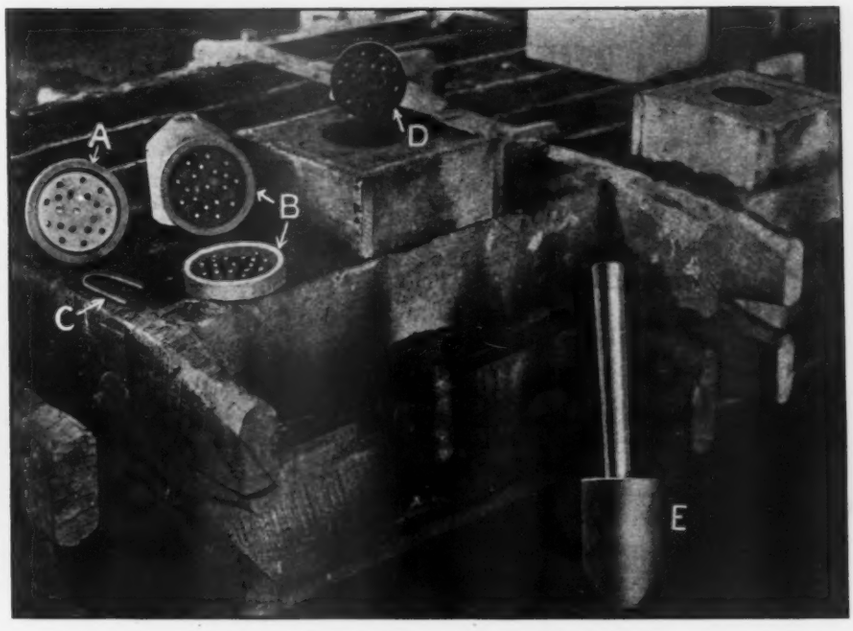


FIG. 5—HOW AN EFFECTIVE TYPE OF SKIM-GATE IS MADE—*A* AND *C* ARE USED TO MAKE THE CORE BOXES, *BB*

A Simple Gagger Board

Gaggers play an important part in a gray iron foundry. It is often desirable to make a simple gagger board at the lowest possible cost. The gagger board illustrated in Fig. 6 represents the minimum of labor and expense, it being made by means of cores instead of a mold of the ordinary kind. The cores are made from the half-pattern board shown at the right. This board is simply placed upon a bottom-board and packed with core sand. Two sand molds made in this manner are baked and then pasted together to form a single mold. These cores are placed in an upright position similar to that of the pattern board shown at the right in Fig. 6, and the metal is poured while the cores are in this position. After the metal has set, the cores are torn apart; one of the castings is shown at the left, Fig. 6. Ordinary silica sand which vents freely, is used for the cores in which this gagger board is made.

The foundry is equipped with various details of auxiliary equipment which greatly reduce operating expenses. The molds are dried by gas torches supplied from gas lines suspended from each column in the building. Air lines parallel the gas lines, the pressure being maintained at 70 pounds per square inch. The air is used in connection with the gas torches and for driving the pneumatic chipping hammers. Sand for the molds is sifted by means of a Combs gyratory riddle manufactured by the Great Western Mfg. Co., Leavenworth, Kans. In addition to the ordinary gas

FIG. 6—A GAGGER BOARD IS A USEFUL ADJUNCT TO THE FOUNDRY—INSTEAD OF USING AN EXPENSIVE PATTERN AND AN INTRICATE MOLD TO MAKE THE GAGGER BOARD, CORES ARE MADE FROM A HALF BOARD, PASTED TOGETHER, AND USED AS A MOLD

THE POWER MANUFACTURING COMPANY

MARION, OHIO

HEAT REPORT OF LABOR

FOUNDRY DEPARTMENT

Date .....

Quantity	PATTERN NO.	Cost	Workman No. 35 117	Workman No. 32 121	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.
2	J.K.68	3.50	3.02	.28	etc.							

FIG. 7—THE LABOR CHARGES ON THE VARIOUS JOBS ARE COLLECTED FROM TIME SLIPS AND ARE ENTERED ON THIS FORM

flame for drying molds, small torches, furnished by the Mahr Mfg. Co., Minneapolis, are used. Sand for all purposes is mixed by a Blystone mixer.

One of the problems which confronted the engineers who laid out the foundry was the design of a suitable core oven. An oven of the car type, 14 feet wide, 20 feet long and 7 feet 8 inches high, was built and lined with refractory brick. In one corner of the oven, a grate, 3 feet square, was provided. It was designed for coke and it was planned that this fuel would be charged in the evening just before quitting time in a sufficient quantity to last all night so that the cores would be properly baked when the men resumed work in the morning. This plan proved satisfactory as long as the price of coke remained at from $2 to $5 per ton, which prices prevailed when this equipment was first installed. However, when the price of coke approached $10, the company decided that this fuel could no longer be used economically in the core oven. Therefore, the grate was slightly altered to accommodate bituminous coal instead of coke, and this has since been used. About 225 pounds of coal are charged each evening and this is sufficient to last all night. The cores are properly baked when

The Power Manufacturing Company

FOUNDRY DEPARTMENT

Daily Report of Cast

MARION, OHIO 2 27 1917

	PIG IRON No. 2 S. steel	500			4	50
	PIG IRON No. 2 N. #2	4400		6	9	30
	PIG IRON No. #4	5900		8	8	50
	SCRAP IRON	4200		3	7	80
	COKE	2000			7	50
	SAND				2	00
	LABOR		1	0	6	68
	FIXED CHARGES			2	5	00
	Total Cost		3	4	1	28
	lbs. Job Castings @					
	lbs. Job Castings @					
	lbs. Job Castings @					
12147	lbs. Companys Castings @		3	3	4	05
	lbs. Scrap returned 2400			2	1	60
	Total Value		3	5	5	65
	Net Gain				14	37

FOR ITEMIZED LIST OF CASTINGS SEE OTHER SIDE

FIG. 8—FACSIMILE OF FACE OF DAILY REPORT CARD SHOWING SUMMARY OF EXPENSES AND VALUE OF THE PRODUCT

Itemized List of Castings

QUANTITY	PATTERN NO.	WEIGHT	ORDER NO.	OUR ORDER NO.
5	689	33	251	32896

FIG. 9—FACSIMILE OF REVERSE SIDE OF DAILY REPORT CARD—THE CASTINGS MADE, THEIR QUANTITY AND WEIGHTS ARE LISTED

THE POWER MANUFACTURING CO.

Marion, Ohio

FOUNDRY COST REPORT BY PIECE

Date.....

Quantity	Pattern No.	OWNER	Weight	Worth	Mat.	Mould	Core	Total Cost	Loss	Profit
5	689	Power Mfg. Co.	33	.91	.58	1.19		1.77	.86	
2	4468		15	.42	.27	.41		.68	.26	
		Total	12147	334.05	212.58	87.94	17.79	318.31	40.82	56.56

FIG. 10—A COST REPORT WHICH ENABLES THE FOUNDRYMAN TO CHECK-UP THE COST OF EACH GROUP OF CASTINGS

taken out in the morning and so efficient is this core oven that small cores placed on the floor of the oven are suitably baked when discharged. This represents a big improvement over the operation of the coke-fired oven, when it was necessary to change the position of various cores in order that they might receive the proper degree of heat. The cost for fuel for this oven averages less than 35 cents per day.

Cost Accounting System

It is usually true, in the case of a small foundry, that the balance between profit and loss is easily disturbed by lack of economical methods in certain operations in the foundry. Therefore, it is essential that an accurate and simple cost accounting system be employed in order that the foundryman may know at all times how closely he is adhering to the estimated cost of the product. Figs. 8 and 9 show the daily report of castings which is filled out at the foundry of the Power Mfg. Co. On one side of the sheet are shown the amount of pig iron, gas, coke and sand used for the heat. As shown in Fig. 8, the amount filled-in in the last column indicates the actual cost of the material and labor and the fixed charges. The total, which in this case amounts to $341.28, should agree with the determined value of the castings made. At the bottom of the face of this sheet, it is shown that 12,147 pounds of castings, valued at $334.05, were made for the company. It is also shown that 2,400 pounds of scrap were returned, and this represents a credit of $21.60, which is added to the value of the castings made. This gives a total value of $355.65, which is $14.37 in excess of the total cost of these castings. The $14.37 represents the net gain for the day. On the opposite side of this sheet, which is illustrated in Fig. 9, are listed the quantity, pattern number, weight and order number of the various castings made from this particular cast. The total weight shown on the reverse side of the daily report of castings made should agree with the total in the lower part of the front side of the sheet.

Time Slip, Foundry Department

THE POWER MANUFACTURING COMPANY

MARION, OHIO

MAKE	MADE	PATTERN			
			UNFINISHED		
			FINISHED		
			START		
			OUT NOON		
			IN NOON		

Workman No. Time Consumed

FIG. 11—THE TIME SLIP FROM WHICH THE LABOR CHARGES ARE OBTAINED —THE TIME CLOCK IS GRADUATED IN HOURS AND FRACTIONAL HOURS INSTEAD OF HOURS AND MINUTES

INTERDEPARTMENT MESSAGE
The Power Mfg.. Co. Nº 94G

Date.....

To.....

Nº 94G

To..... Date.....

File this stub until instructions have been complied with, then destroy same

Signed.....

Use this for all shop messages; not for scrap paper. When message is received from another department make reply promptly on reverse of message received

FIG. 12—A SIMPLE FORM FOR INTER-DEPARTMENTAL MESSAGES

Data from Time Slips

In filling-out the items shown at the top of Fig. 8, the cost of material such as steel, No. 2 pig iron, No. 4 pig iron, scrap iron, coke, etc., is taken from records giving the cost of the material. The fixed charges have been previously determined, $25 representing the average which is charged to each day's cast. The amount applicable to labor is determined direct from the time slips punched with a time clock by the workmen in the foundry. These time cards are similar to the one shown in Fig. 11.

(*Concluded on page 222*)

Castings From Acid and Basic Electric Steel

Pertinent Suggestions From a Practical Operator Bearing Upon This New Foundry Process for the Production of Small Castings

By A Walter Lorenz

ONLY a few years ago the application of the electric furnace to the manufacture of steel was chiefly confined to the making of high-grade metal where cost was of secondary importance to the quality of the product. Within the last few years, however, a wide field has been found for electric furnaces in the manufacture of small steel castings. This has been due partly to the demand for a superior product, but mainly to the constantly decreasing cost of electric power, which now enables this process to enter into active competition with the older methods. Electric steel cannot yet be made in large quantities as cheaply as either acid or basic open-hearth, except in certain districts, and for this reason we do not find many plants devoted to the manufacture of large electric steel castings.

Low Cost of Electric Steel

Electric steel really can be made at the present time at a much lower cost than is generally imagined. The prevailing impression that the cost of power is prohibitive deters many from fully investigating the economical features of electric practice. It will be found that the cost of power will be compensated for to a large extent by the lower cost of raw material used (plate scrap, etc.), as compared with the cost of pig iron. At the present time, this is quite a considerable item. Moreover, the cost of ferro-manganese, ferro-silicon, and other special additions per ton of electric steel is only a small fraction of the cost of similar additions per ton of steel made in other furnaces. This saving is effected by the use of low-grade alloys and by the fact that the amount of alloy required for a ton of ordinary electric steel is very small. In the basic electric process, for instance, the bath when melted always contains from 0.20 to 0.30 per cent manganese, and it is only necessary to raise this 0.50 per cent to secure a product as good as the average converter product of 0.60 to 0.70 per cent manganese. Even this small increase of 0.2 is accomplished with a minimum of manganese, since there is absolutely no loss. One electric steel plant figures that its manganese additions cost only \$0.09½ per ton of steel.

When the electric furnace first entered this field, basic practice had already become standard in the manufacture of electric tool steel, and for this reason, perhaps, we find that a similar practice was adopted for the manufacture of steel for casting purposes.

Basic Furnace Bottom

The furnace bottom for basic practice is made up of magnesite. This is sometimes bonded with tar, but since this type of bottom has not proved very satisfactory, due probably to lack of experience in building, it is the usual practice to mix the magnesite with about 20 to 25 per cent basic slag. This mixture is burned-in thoroughly, a layer at a time, by means of the electric arc. Objection may be found to this type of bottom also, for even though iron oxide in the form of basic slag is an accepted bonding material for basic open-hearth bottoms, its use in the electric furnace for a similar purpose is questionable. Here there are strong reducing influences at work, which are not present in open-hearth practice, and under these influences the iron oxide is readily converted into metallic iron. A striking example of this action came to the attention of the writer recently while inspecting the fresh bottom of a new furnace. This bottom was made by burning-in a mixture of magnesite and basic slag by means of the resistance generated in a pile of coke and broken electrodes placed on top. When the furnace was opened, the bottom, for a depth of about 6 inches, was almost white in color and slaked rapidly in air, while particles of iron ranging in size from small globules to pieces the size of an egg were interspersed throughout the mass. By reduction to metallic iron, the iron oxide not only loses its bonding properties, but may even be injurious, since the metallic iron formed has a tendency to become pasty and melt under high temperature, loosening portions of the bottom, and thus cause trouble, as will be noted later. Difficulties of the foregoing nature, however, are rare, and, on the whole, a bottom of this type gives satisfactory service.

Theoretically, any kind of scrap should produce good metal on a basic bottom, but there are certain considerations which demand the use of clean, high-grade material in this no less than in the acid process. The scrap must not be dirty, or the impurities will rapidly attack the lining and bottom, under the influence of the high heat, which prevails in all electric furnaces. It would seem that the percentage of phosphorus and sulphur in the raw material should be of little consequence, since one important advantage claimed for the basic-lined electric furnace is the ability to remove them almost entirely. This is quite true, but these elements, especially phosphorus, can be removed almost as completely in a basic open-hearth furnace, and at much less cost, so that it seems poor policy to do any unnecessary refining in the electric furnace, and it will generally be more economical to use fairly good scrap in the first place.

Charging the Furnace

When charging, the scrap, consisting of heads, gates, plate punchings, rails, or other clean material of good quality, is placed in the furnace with the required amount of lime for slag-making purposes. When using scrap under 0.075 per cent phosphorus, there is generally sufficient oxide in the charge to carry the greater part of the phosphorus into the slag. When the charge is thoroughly melted, this phos-bearing slag is drawn off as completely as possible. Such a slag has practically the same composition as a normal basic open-hearth slag, although considerably lower in iron oxide. Some manganese is carried off with this slag, but its removal in the basic process is never as complete as in the acid, and, as stated previously, 0.2 to 0.3 per cent always will be left in the bath. If slagging has been carefully conducted, the bath will be practically free from phosphorus, but will still contain considerable sulphur.

Another slag is now formed by the addition of more lime, which is cut up with a little sand or fluorspar. A reducing action is now started by the addition of silicon or carbon. As silicon is comparatively expensive and it is difficult to regulate the silicon content of the bath when this material is used, it is more general to employ carbon. In this case, when the slag is sufficiently fluid, powdered

coke is added, which interacts slowly to remove the oxides present and afterward to form calcium carbide. The manganese may be introduced at almost any time; the sooner the better, as it helps in the deoxidation of the bath and removal of the sulphur. The attainment of a good carbide slag has been held to be an indication that deoxidation is complete. It is certainly an indication that deoxidation of the slag itself is complete, since a carbide slag rarely contains over 0.5 per cent of the oxides of iron and manganese.

It cannot be said, however, that a carbide slag is evidence of a deoxidized bath, nor does it seem to be true, as has often been claimed, that a carbide slag plays any great part in the complete deoxidation of the bath itself, except to act as a protective coating against the air. The writer has seen metal, which after laying under a carbide slag for an hour, still seemed as wild as ever. This statement refers, of course, to baths low in carbon, which are always more difficult to deoxidize than high carbon melts. The addition of some alloy, such as ferro-silicon, which will thoroughly disseminate itself through the bath, rather than a substance which merely floats on top of it, seems necessary in order to remove the last traces of oxide, for the circulation in the bath itself is of little consequence in most electric furnaces.

Regulation of Manganese Content

The almost complete reduction of MnO from the slag attests to the ease and exactness with which the manganese content of the bath may be regulated. If the residual manganese in the bath after removal of the first slag has been determined by analysis, then it is only necessary to add the exact amount lacking, to bring it up to the desired percentage. No other method (except the crucible process) is capable of regulating manganese with such great accuracy.

Carbon always should be adjusted near the end of the heat, since pieces of electrodes, or coke from an imperfectly fused slag, may enter the bath and cause trouble after the carbon, from all indications, is about right. If this should occur, it may mean the loss of much time and energy, since the carbon cannot be removed after the reducing period has commenced except by bringing the furnace back to an oxidized condition by means of ore, after which it is again necessary to repeat all the subsequent operations of reduction before the heat can be tapped. For this reason it is advisable to bring the carbon well on the low side before commencing reduction, and then add the requisite amount of carbonizing material at the end of the heat to bring the carbon up to the desired percentage. In this way the carbon can be regulated with great accuracy by an experienced melter.

The Control of Silicon

The control of silicon presents some difficulties. While it has been said that no loss attends the introduction of silicon in the electric furnace, this statement does not always hold true. The silicon content of the melt may sometimes come out exactly as calculated if conditions are right in the furnace, but it may just as often be high or low. The obvious reason for adding silicon to steel is to complete the deoxidation, and in the performance of this function, some silicon must necessarily go to the slag. It has already been said that a carbide slag alone is insufficient to deoxidize a low carbon bath perfectly. Not until the addition of silicon does the bath become perfectly quiet. Hence, we can generally figure on losing a small amount of silicon in this way. On the other hand, if reducing conditions are extremely powerful within the furnace, and the slag is not sufficiently basic, then some silica from the slag may be reduced, and even more will be found in the bath than was desired.

The writer has found the silicon in various heats of electric steel treated in the same manner to vary about 0.20 per cent, being sometimes higher and sometimes lower than calculated. Of course, such a variation is by no means harmful in casting steel, and attention is merely called to the matter here to show the variations between theory and practice. Silicon generally is added from 10 to 30 minutes before a heat is tapped. It may seem that a somewhat longer treatment should produce better results, but this may lead to trouble on account of the fact that no matter how perfectly a bath has been deoxidized, and no matter how free from oxides is the slag which covers it, the bath, nevertheless, is lying on a bottom which contains a considerable proportion of iron oxide.

Magnesite generally contains 5 to 8 per cent. Fe_2O_3 and basic slag, frequently used for bonding purposes, 10 to 15 per cent. FeO. This bottom always has a tendency to react with a well deoxidized bath, especially if pieces of bottom have become loose during the course of a melt, and it sometimes happens that an excellent heat may be ruined by the coming-up of a portion of the bottom just before tapping-out. The interfering action of the bottom would, of course, cause loss of an appreciable amount of silicon if this was left in the furnace for too long a period. Regarding the addition of aluminum in the furnace for the final deoxidation, which is held to be one of the advantages inherent to basic electric practice, it may be said that no benefit seems to be derived from this procedure. Even if the bath has been perfectly deoxidized in the furnace, there is always a certain amount of deoxidation during pouring, and for this reason many electric steel casting manufacturers have gone back to the addition of aluminum in the ladle.

While some of the foregoing statements may not fit into the general conception as to the possibilities of the basic electric process, it must be expected that many difficulties will arise in the manufacture of steel castings which are not present in the making of steel for forging or rolling purposes. For this reason a compromise must sometimes be made between theoretical considerations and the possibilities of actual practice. Such difficulties as are encountered are of a minor nature, and the practice is gradually being improved and standardized, so that at the present time castings of excellent quality are being made.

The Acid Process

The chief advantage of the acid process lies in the fact that heats can be run out in less time than on a basic lining, resulting in greater output with decreased power consumption.

A careful selection of scrap is necessary in order to keep the impurities at a minimum. Removal of phosphorus and sulphur as in the basic process is not possible, but this is only a small disadvantage, since by the use of basic open-hearth scrap the phosphorus may readily be kept below 0.02 per cent and the sulphur below 0.03 per cent. Acid electric practice follows in general along the same lines as acid open-hearth, except for a final reduction period, during which all oxides are practically eliminated from the bath. Deoxidation must be accomplished by ferro-manganese almost entirely, since coke has a tendency to react with the large percentage of silica, in an acid slag, introducing an undesirable amount of silicon into the bath. It is unnecessary, as a rule, to add ferro-silicon to the bath in the final stages, and, in fact, one of the problems of acid electric practice is to keep the silicon within due bounds. Its regulation is not nearly as simple as in the basic process, and it may sometimes run as high as 0.6 per cent. Whether silicon in this proportion is injurious to the steel is still a debatable question among metallurgists.

Since manganese is the chief reducing agent employed in the acid process, it follows that this element cannot be regulated as well as in the basic process, as it is difficult to tell just how much has been used for oxidation and how much remains in the bath. Practice enables a melter to regulate it within fair bounds by means of mechanical tests and standardization, but its adjustment can never be as satisfactory as in the basic process.

Deoxidation on Acid Bottom

It has been claimed on theoretical grounds that deoxidation in an acid bottom cannot be as perfect as on a basic bottom, but practical results would indicate that the final products are about equal in this respect. It is true that a final slag from an acid heat will be much higher in oxides than the calcium carbide slag of a basic furnace, but the oxygen is almost entirely combined as MnO, and the percentage of iron oxide is just as low as in a basic slag, being under 0.5 per cent, with the MnO running about 10 per cent. It is evident that the manganese performs its function well, and even though the percentage of MnO is high, the affinity of manganese for oxygen is such as to prevent reabsorption of oxygen from this source by the bath. In other words, the MnO is perfectly neutral and seems to have no effect whatever on the bath.

Carbon can be regulated at will by the melter with approximately the same precision as in basic practice.

Acid electric steel is somewhat easier to pour than basic steel, since a basic carbide slag does not clean well from the molten metal. Aluminum is added in the ladle.

Acid and Basic Steel Similarities

To all intents and purposes, except for regularity of chemical composition, acid electric steel in the ladle, in the mold, and in use, seems to be identical with basic steel when proper care has been employed in its manufacture. Molding and foundry practice play a large part in the production of perfect castings, and after all, the quality of the metal itsef is only one factor to be considered when comparing the ultimate product. Each process has its merits and until the product of one shows a decided superiority over that of the other, the final decision will probably be made by the steel foundryman himself in favor of the process best adapted for economical operation in his particular field.

Electric furnace practice today is, of course, capable of great improvement. There is much faulty design to be corrected, and there are many problems in practice which still remain unsolved, due mainly to lack of experienced operators.

Keeping Down Operating Expenses in a Small Gray Iron Foundry

(*Continued from page 219.*)

Each workman fills out the first, second and third columns showing, respectively, the number of pieces he was to make, the number he did make, and the pattern number of the piece. The clock punches hours and decimal parts of hours instead of hours and minutes. Inasmuch as the columns are arranged for the convenience of the time clerk rather than the convenience of the workman, it is necessary only to subtract the amount shown in the first and second columns to secure the net amount of time consumed on a fixed job. The information on these time slips is then collected by the time clerk on the last form entitled "Heat Report of Labor", shown in Fig. 7. On this report are spaces in which the time consumed by various workmen may be entered and the overhead expense is entered in the first column under the heading "Cost". The total from each of these sheets represents the amount shown under "Labor" in the form shown in Fig. 8.

As a check to determine whether any castings are costing more than the estimate made, the form shown in Fig. 10 is used. Information for the first two columns of this form is taken from the back of the daily cast report, illustrated in Fig. 9. The amount shown under "Worth" is obtained by multiplying the weight in pounds by the estimated value of the castings. In the following column, the actual cost taken from time cards and from material sheets, is entered and then the total cost, as compared with the estimated value of the castings, indicates at a glance whether the job has been done at a loss or a profit. The difference between the total loss and total profit should approximate the net gain or net loss shown on the face of the form, Fig. 8. This comparison is a test of the accuracy of the system.

It is the experience of many men in manufacturing plants that much of the routine correspondence between offices usually is handled in a slip-shod manner. Fig. 12 shows a blank for interdepartmental messages which has proved of unusual value in the plant of the Power Mfg. Co. It is useful for correspondence which does not merit the dignity of a letter-head. The numbered stub is retained as a reminder until the reply, written on the back of the sheet, is received. The use of this form has encouraged the prompt handling of messages.

Losses in Melting Cast Iron

By W. J. Keep

Question:—We would like to know the percentage of melting loss in the operation of a small foundry. What are the average yard losses in handling pig iron? Also, kindly advise the yard losses in handling and breaking scrap iron.

Answer:—It is impossible to ascertain such losses in the ordinary foundry routine. Some years ago, to ascertain the actual loss, I swept the foundry floors, scaffolds, riddled the sand heaps and made one-ton heats of pig and scrap and also made one regular heat. The results are given in the following table:

One ton heats of each	Pounds loss per ton	Per-centage of loss
No. 1 Cherry Valley pig iron, silicon, 2.72 per cent; sulphur, 0.01 per cent.....	59	4.75
Cleaned new stove plate.....	159	7.59
Cleaned stove plate sprues....	130	6.50
Old stove plate scrap—purch..	227	11.35
New stove plate with sand on	230	11.50
New stove plate sprues with sand on	280	14.00
A 37-ton heat of regular melt of stove plate:		
Calculated from above experiments	116	5.80
Actual, all precautions taken.	88	4.41

The regular heat consisted of 37 tons and the shot and screenings recovered from the gangway amounted to 26 pounds per ton of iron melted. The coke recovered from the cupola totaled 57 pounds per ton; limestone flux used, 43 pounds per ton; slag tapped out, 207 pounds per ton, with a melting ratio of 9 : 1. In ordinary foundry melting operations a loss of 5 per cent is probably correct on the average. Owing to careless weighing more iron often is taken out of the cupola than is charged and it is difficult to locate the trouble. The investigation which I made was on stove plate and I have no data on machinery casting losses. However, in a foundry making machinery castings the losses should be less than for stove plate, since the rust on the scrap and the sand on machinery castings is much less than on old or new stove plate and agricultural scrap. Machine-cast pig iron should show no loss in yard handling. During the year's operations some scrap pig is liable to be buried in the yard, which can be dug up at inventory time. However, you will find it very difficult to make your books balance on the total pig consumption and to balance the coke account is still more difficult. I find that if the accounts do balance, it is largely accidental. The class of men usually employed in the iron yard and on the charging floor makes accuracy difficult of attainment. In many foundries the coke is measured and is not weighed, while in some other shops the pig iron is not weighed.

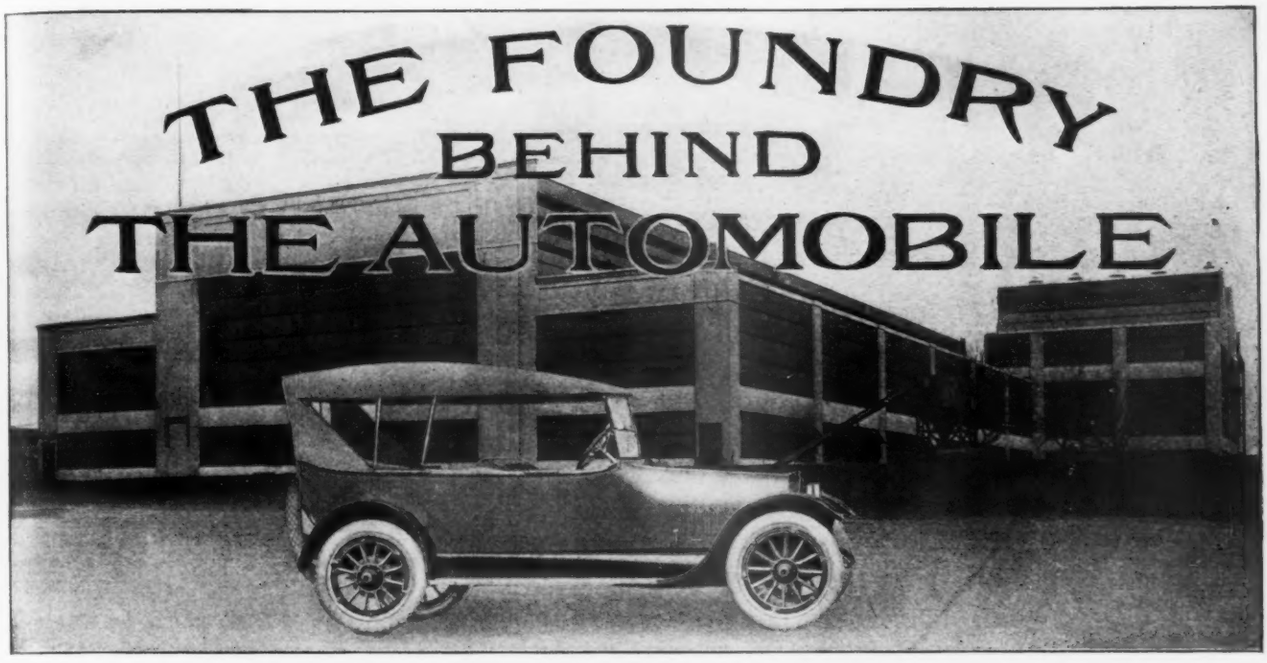


Fig. 1—Exterior view of the new foundry of the Buick Motor Co., Flint., Mich. The cupola bay is shown at the right

This Shop Will Melt 240 Tons of Iron Daily

WHEN John Houston Bardell, composite personification of thousands of owners of American-made motor cars, manipulates the various push-buttons, levers, etc., which set his machine in motion, he little realizes that under the glossy hood of polished metal is a wonderful mechanism, the achievement of science applied to industry. If Mr. Bardell would remove the hood, and could replace a section of the cylinder walls with a transparent material, he would be surprised at the terrific explosions which follow the ignition of the gas. Moreover, he would doubtless be alarmed if he realized that the force of these explosions is repelled by a thin shell of cast iron only 5/32-inch thick. If Mr. Bardell were an experienced foundryman, he would more fully appreciate the amount of study, experiment and effort that has been necessary to develop casting plants to the degree of perfection required to produce hundreds of cylinder blocks of unvarying quality from day to day.

The general public, Mr. Bardell included, is doubtless aware of the fact that behind the finished automobile is a wonderful organization and a well-equipped factory. The manner in

FIG. 2—THE MOLDING FLOOR IN THE BUICK FOUNDRY—NOTE THE SAND HOPPERS AND GRATES IN THE FLOORS

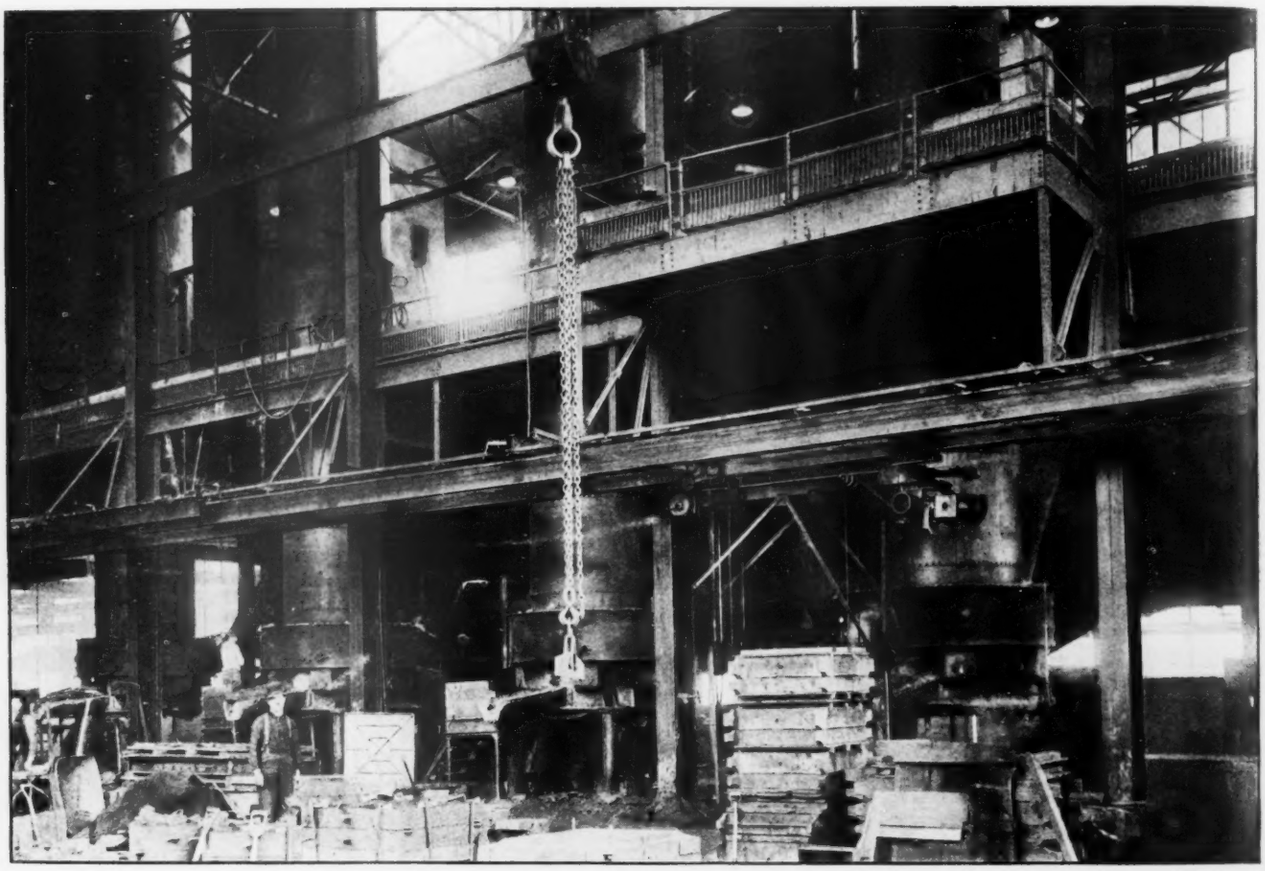


FIG. 3—FOUR OF THE CUPOLAS IN THE BUICK FOUNDRY—THE BLOWING EQUIPMENT IS ON THE FIRST BALCONY AND THE CHARGING PLATFORM IS DIRECTLY ABOVE

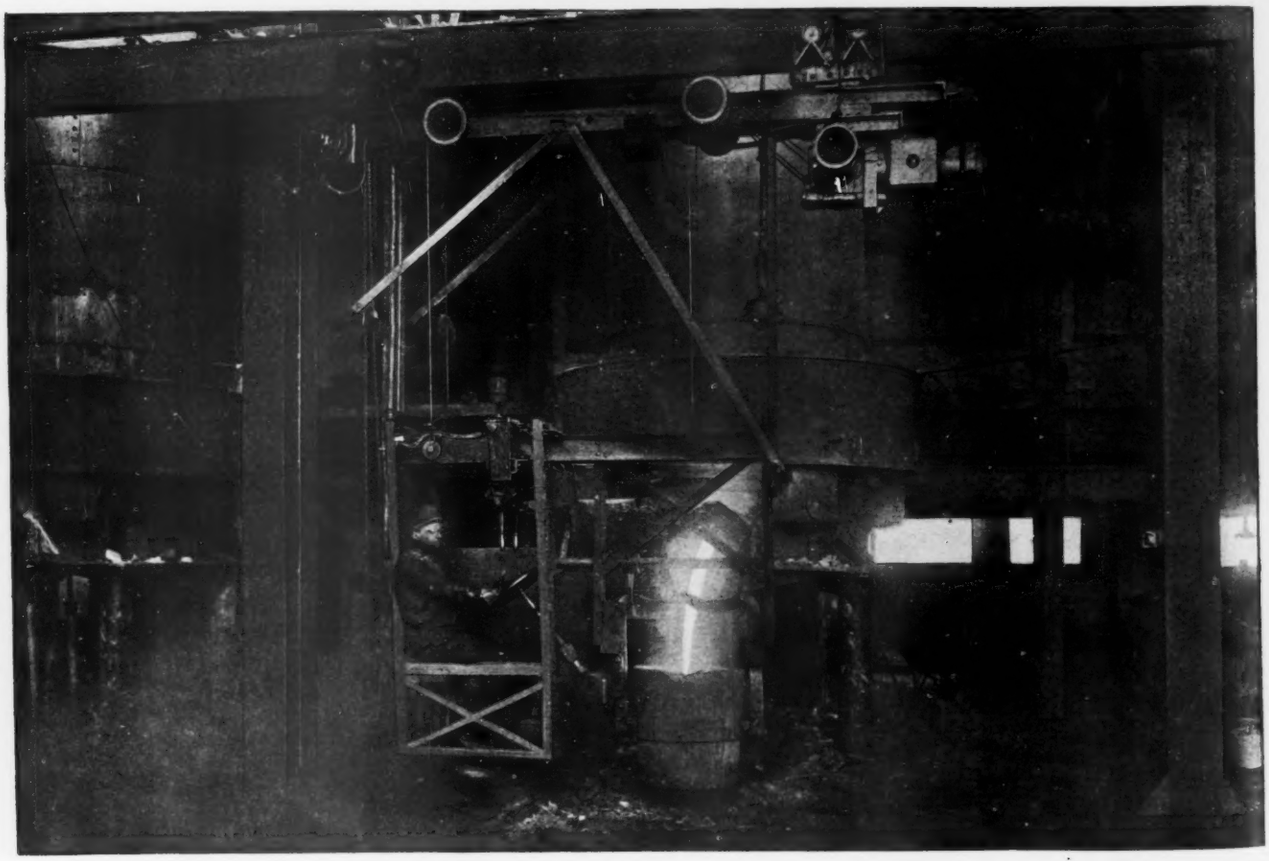


FIG. 4—TELPHER LADLE CARS OF UNUSUAL DESIGN—THE OPERATOR'S CAGE AND THE LADLE MOVE IN A VERTICAL POSITION ALONG GUIDES, THUS ENABLING THE OPERATOR TO LOWER THE CAR FOR CHARGING AS SHOWN IN THE ILLUSTRATION

which the designing engineers have struggled with the relative importance of weight and strength, and have tried to arrive at an equitable compromise between quality and expense has been made known through the medium of the sales talk and advertising literature of automobile manufacturers. However, little regarding the manner in which the operating forces, and particularly the foundry, have carried out the ideas of the engineers is known.

In developing the automobile engine to its present state of perfection, foundrymen have been taxed to the utmost of their ability and resources to meet the constantly changing requirements. The weight of the cylinder blocks and the walls of the cylinders have been constantly decreased in the effort to secure the maximum power from engines having the least possible weight. That foundrymen have kept up with the ever-increasing difficult requirements is only due to their ability to improve the quality of the metal and to develop the methods of coremaking, molding and pouring to a point permitting the production of hundreds of high-grade castings each day. In order to accomplish this result, foundrymen have been obliged to bring into play a considerable amount of automatic sand and metal handling apparatus, molding machines, and intricate systems for conveying castings and materials in the foundry. In fact, the requirements of the automobile industry have created a new kind of foundry which has many distinctive features not found in other types of casting plants.

One of the best examples of the new type of automobile foundry is the new plant of the Buick Motor Co., Flint, Mich. In addition to being one of the most modern casting plants of this kind, the Buick foundry is one of the largest, if not the largest gray iron foundry in the world. When operating at capacity, about 240 tons of castings will be made each day and more than 1,500 men and women will be employed. Practically all of the gray iron castings used in the construction of the Buick automobile are made in this new foundry, cylinder blocks constituting the principal output of the plant.

The outstanding feature of this foundry is the elaborate system of conveying apparatus for handling sand, castings, and molten iron. These conveying systems are not confined to the molding floor or sand storage floor, but extend to all parts of the building in such a manner that all materials are handled with the least possible amount of hand labor. The conveying and elevating apparatus has been so carefully worked out in connection with the design of the foundry building that its presence is not always conspicuous.

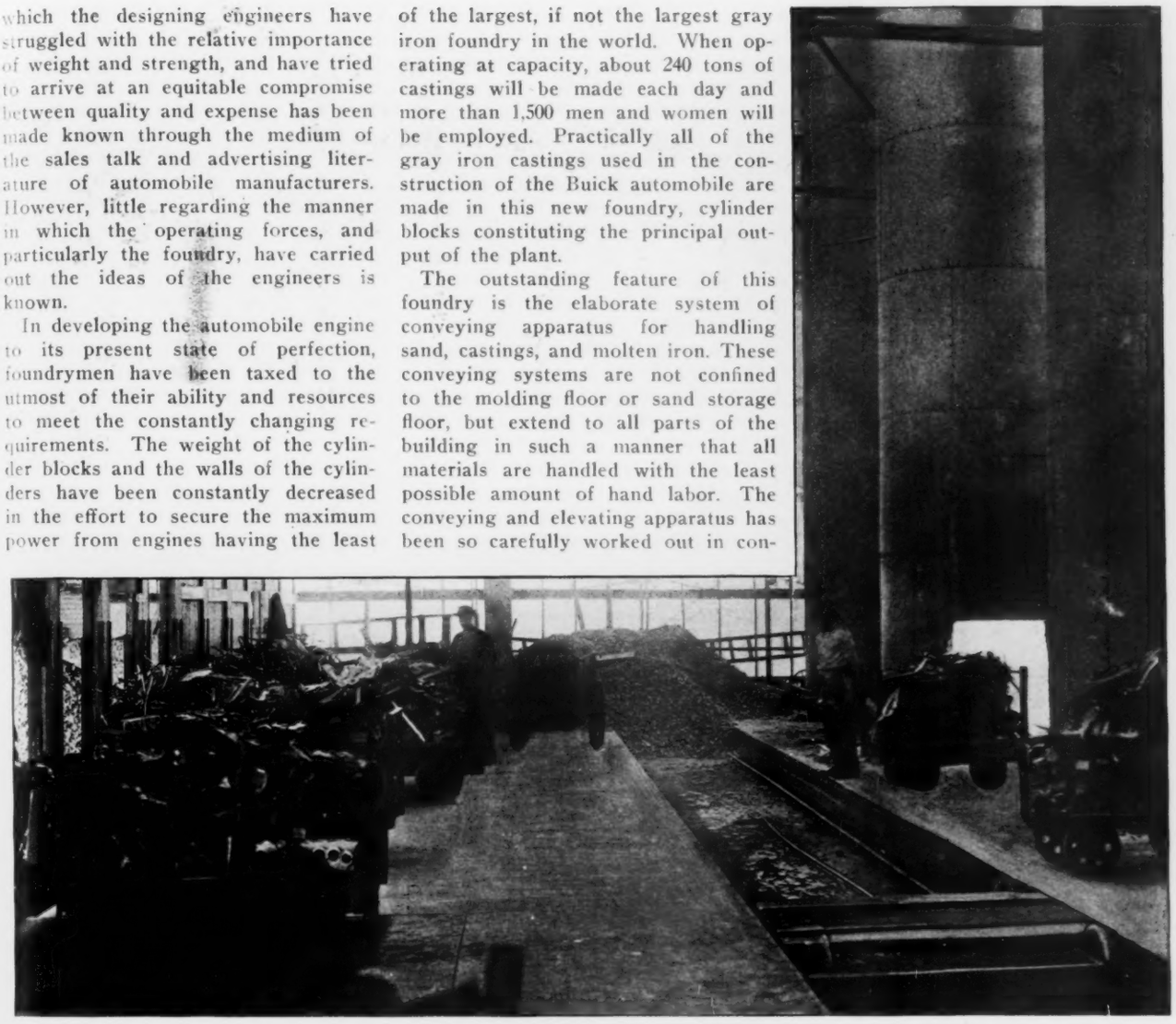


FIG. 5—A VIEW OF THE CHARGING FLOOR—THE TRANSFER TABLE ENABLES THE TRUCK OF MATERIAL TO BE MOVED TO ANY OF THE CUPOLAS

New sand is brought into the foundry on an 18-inch fibre belt, which travels near the ceiling of the first floor, as shown in Fig. 9. Wooden flange boards operated by ropes from below may be pulled down against the belt to divert sand at various points along the floor. The core and facing sands are directed to mixers made by the Standard Sand & Machine Co., Cleveland, where they are prepared for use. From the mixers, the sand is lifted to the second floor of the foundry, which is the molding floor, by means of elevators manufactured by the C. O. Bartlett & Snow Co., Cleveland.

The molding sand is handled on the first floor at the north end of the building. From here it is elevated to hoppers supported in the roof above the second floor by means of elevators built by the Palmer-Bee Co., Detroit. The hoppers have tapering sides and at the bottom divide into two rectangular-shaped chutes which straddle a monorail track. Specially-built telpher cars, constructed by the Sprague Electric Works, New York, are used to handle the sand. The sand is carried in a large, rectangular steel box attached to the telpher car and fits under the two chutes of the sand hoppers when in the filling position. When the car has been filled, the operator, whose cage is directly behind the sand box, moves the car along the monorail track to the point where the sand is to be discharged. The monorail track carrying the sand conveying telpher cars is directly over a two-rail track, on which a number of moving molding sand hoppers are situated. These hoppers have a rectangular-shaped opening at the top, which tapers down to a cylindrical body opened at one side at the bottom and securely bolted to a horizontal

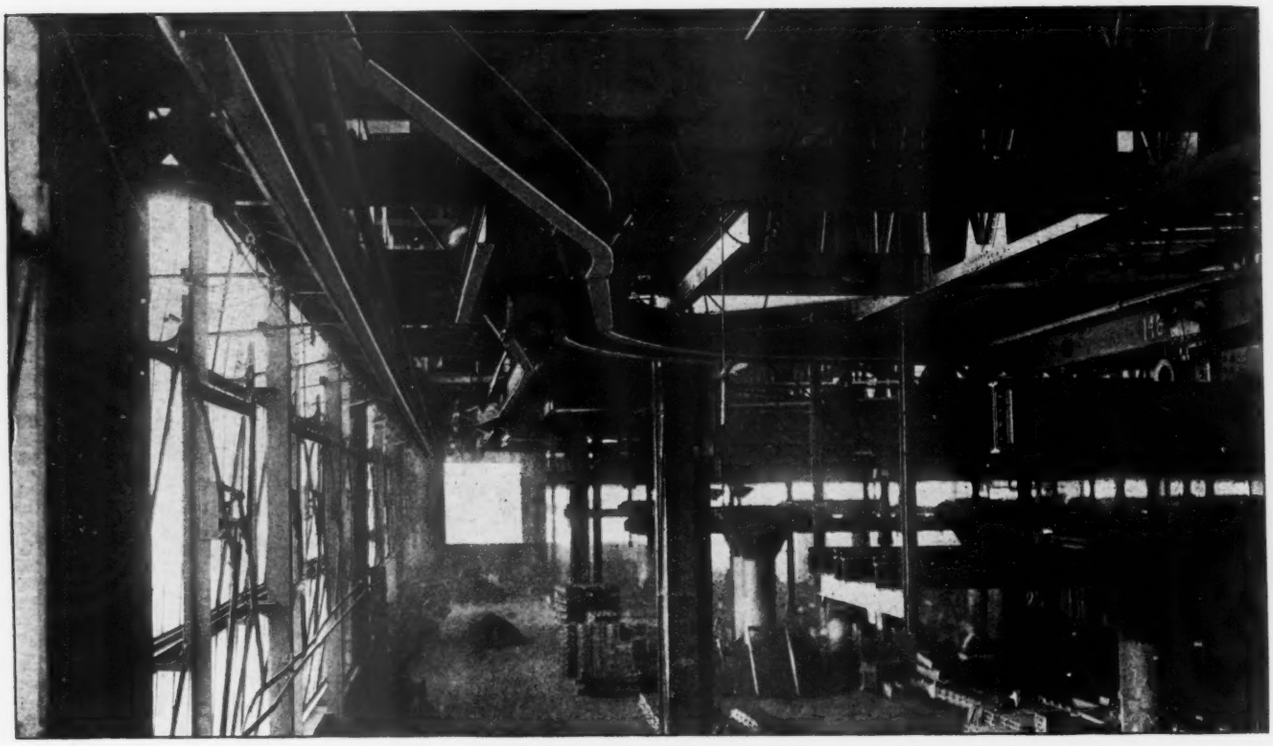


FIG. 6—A VIEW OF THE ROOF GIRDER CONSTRUCTION SHOWING THE ARRANGEMENT OF MONORAIL TRACKS AND SWITCHES

table, which serves as a floor for the hopper. When the telpher car operator has placed his car with the sand over one of these hoppers, he can release the sand by turning a hand wheel which opens drop doors in the bottom of the sand box. The falling sand rests upon the floor or the movable hoppers, where it is always within easy reach of the molders. Fig. 7 gives a view of one of these moving hoppers, and shows how conveniently the sand is placed at the disposal of the molders. Since these movable hoppers are suspended by four-wheel trucks on the tracks above, they may be easily moved along the molding bay to suit the convenience of the workers.

Reclaiming Sand

After the molds have been made, the metal poured, and the castings shaken-out, the sand is discharged through gratings in the floor onto sloping aprons, similar to *A*, Fig. 10, which direct the sand to the first floor of the foundry building. The arrangement of these gratings is such that the sand forms in long heaps in aisles on the first floor. These aisles are served by Sprague electric telpher cars, equipped with motor-operated grab buckets made by the Hayward Co., New York, which pass along the track, pick up charges of the sand and convey them to an aisle extending along the west wall of the first floor of the foundry building. Here the sand is directed to rectangular holes in the floor, which lead to rotary

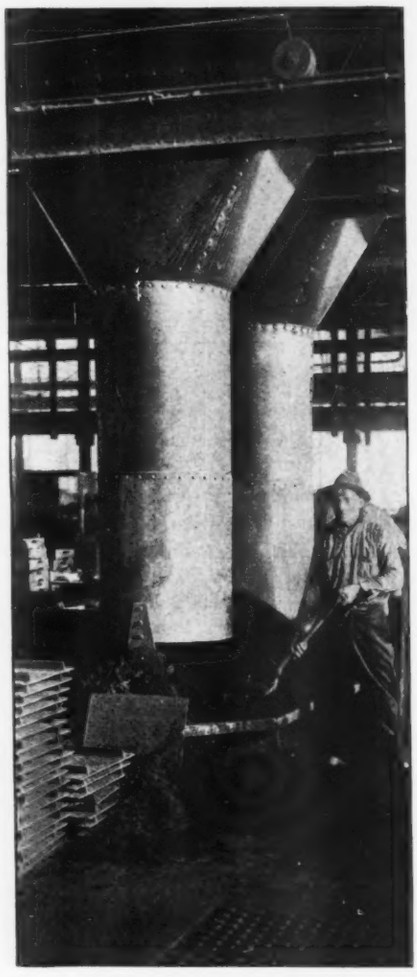


FIG. 7—SAND HOPPERS PROVIDE AN ADEQUATE SUPPLY OF SAND FOR MOLDERS AT ALL TIMES

sieves, located in pits, about 10 feet below the floor level. As the sand passes through the sieves, the reclaimed sand drops onto one of the sand elevators, which carries it up to the hoppers above the molding floor, which already have been mentioned. The hard material separated from the sand, such as sprues, nails, wire, etc., which does not pass through the mesh, falls from the lower end of the open sieve into a receptacle at the bottom of a well served by a 1-ton Sprague Electric Works hoist. This material is easily brought to the level of the first floor by means of this hoist. In Fig. 13, the rectangular column at the right contains the sand elevator; the well and arrangement of the hoist is shown at the left.

Grades of Sand Used

Ohio sands are used for molding purposes and Michigan sands for cores. The core sand used is a mixture of one-half sharp sand and one-half bank sand. About 100 tons of core sand are used daily. The facing sand is a mixture of new sand, old sand, and sea coal, the ratio of sea coal to sand being about one to 16. Approximately 25 tons of new molding sand are used each day and the ratio of molding sand to iron melted is approximately one to eight.

The coke and pig iron storage yards are situated at the north end of the foundry building. The yard is served by a 20-ton crane made by the Pawling & Harnischfeger Co., Milwaukee. The materials to be charged in the cupolas

FIG. 8—SMALL CORES ARE BAKED IN A CONTINUOUS CORE OVEN WHICH CONSISTS OF AN ENDLESS CHAIN CARRYING CORE RACKS

are hoisted by means of this crane to a platform extending outside of the cupola bay of the foundry building. The charges are made up on small cars, which are pushed on small industrial tracks to a place near the cupolas. Here the weights of the various materials are checked by means of floor scales made by the Howe Scale Co., New York, and the Fairbanks Co., Broome, N. Y. The cars are then pushed onto a small transfer table, which runs on a wide track, paralleling the row of five cupolas. By means of this table, the cars may be transferred to any one of the five tracks on the cupola side of the depressed track. The charging platform is shown in Fig. 5.

How Sand is Stored

A sand storage building, 60 x 350 feet, is being erected north of the main foundry structure. The sand will be handled by means of a traveling crane and grab bucket. Provision is also being made for storing 2,500 tons of coke. The fuel will be carried to the charging floor by means of a skip hoist, operated by an electric hoisting engine on the charging floor.

The five cupolas, four of which were manufactured by the W. W. Sly Mfg. Co., Cleveland, and one by Byram & Co., Detroit, are situated in a specially constructed bay at the northeast corner of the foundry building. The four large cupolas, shown in Fig. 3, have 84-inch shells and are lined to an inside diameter of 60 inches. The equipment for supplying the blast for

FIG. 9—AN AISLE IN THE FIRST FLOOR OF THE FOUNDRY BUILDING SHOWING THE MANNER IN WHICH SAND IS HANDLED

the cupolas is situated in a small balcony built at the back of the line of furnaces. The blast is supplied by a blower manufactured by the Piqua Blower Co., Piqua, O., driven by a 50-horsepower Allis-Chalmers motor, running at 865 revolutions per minute. The charging platform is directly above the motor balcony and the ground floor, charging platforms, and the balcony are connected by a large freight elevator, which assists in handling charging material, etc. As operated at the present time, two cupolas are alternated each day, but it is expected that in the near future three of the furnaces will be used daily. The cupolas are provided with blast meters, made by Charles J. Clark, Chicago.

Handling the Molten Metal

One of the most interesting features of the new Buick foundry is the unique method of handling molten iron from the cupolas. The hot iron is tapped from the spout of the cupolas into 2-ton ladles carried in telpher cars of novel design. These cars, one of which is shown in Fig. 4, are suspended from the monorail track by means of double pairs of wheels. The operator's cage and the ladle are in reality, parts of an elevator which slides in vertical guides hung from the track. By means of a motor control, the operator may raise himself and the ladle from the lowest position, as shown in Fig. 4, to the running position which brings the elevator part of the car to a point near

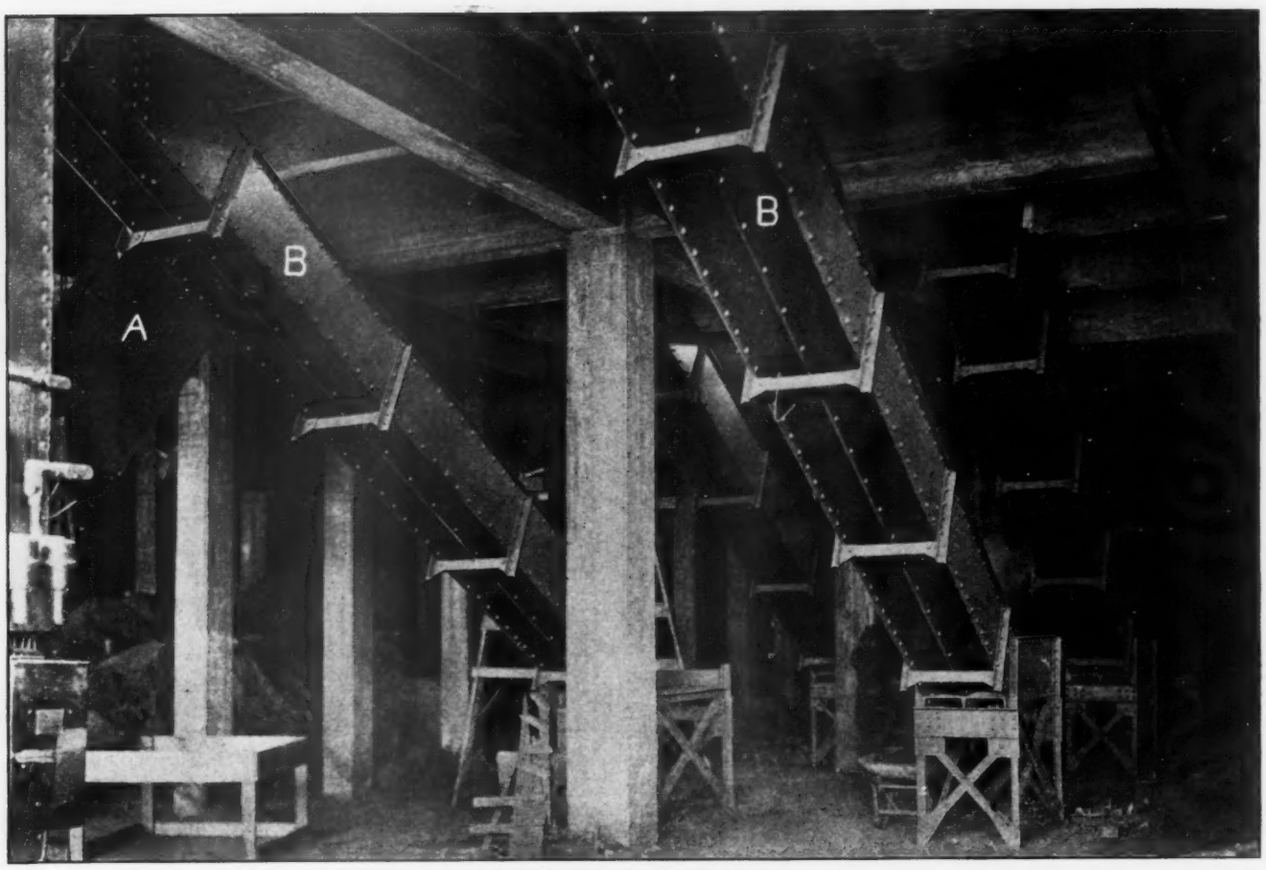


FIG. 10—APRONS AND CHUTES LEADING FROM THE SECOND FLOOR WHICH DIRECT THE SAND AND CASTINGS TO THE FIRST FLOOR

FIG. 11—CORES ARE STORED IN STEEL RACKS—THE METHOD OF DIPPING CORES IN BLACKING ALSO IS SHOWN

the top of the guide, thereby allowing all parts of the car to clear ordinary objects on the molding floor. The ladle is tilted by the operator by means of a wheel which resembles in appearance and action the steering wheel of an automobile. When the operator of one of these cars approaches a cupola to secure a charge of metal, he lowers the elevator part of the car to the low position and then brings the ladle directly under the spout. After the ladle has been filled, he elevates the movable part of the car to the upper position and then proceeds to the molding floor, where he again lowers the elevator to a point near the floor so that he can tilt the ladle to pour the metal into the small distributing ladles handled by the workmen. The system of monorail tracks is such that a number of telpher ladle cars may operate without confusion, there being an adequate number of switches, and loops to enable the cars to circle about the cupolas and await their turn for metal. Fig. 6 gives an idea of the arrangement of the monorail tracks over a molding floor.

Molding Operations

Practically all of the heavy molding is done in the bay directly in front of the row of five cupolas. This portion of the foundry is served by a 10-ton electric traveling crane manufactured by the Pawling & Harnischfeger Co., Milwaukee, Wis. The first molding floor at the north end of the foundry is known as the cylinder bay. This molding floor is arranged with a broad aisle traversing the middle part of the floor and directly under the monorail track. On either side of the aisle are the floors where the molds are set up. The molding machines are arranged on either side of the cylinder bay and are supported on heavy concrete bases which extend from the floor of the molding room through to the first floor and to solid ground. This form of construction was necessary to minimize the vibration set up by the molding machines. The other molding bays are arranged in a manner similar to that of the cylinder bay. The principal types of molding machines used in the new Buick foundry are power jar, power roll, power draw machines, made by the International Molding Machine Co., Chicago; power jolt, hand draw machines, made by the Arcade Mfg. Co., Freeport, Ill.; power jar, power roll, power draw machines, made by the Osborn Mfg. Co., Cleveland, and electric jar machines made by Henry E. Pridmore, Chicago. At the present time the molding floors are operated 10 hours a day. Molding begins at 6 a. m., the first metal is poured at 6:30 a. m., and at 7 o'clock the first castings are shaken-out. At the present writing the daily output of the Buick foundry is about 150 tons, but it is expected that within a short time the full capacity of the plant, which is about 240 tons a day, will be reached.

FIG. 12—JARS FROM THE TRUCK ARE PREVENTED FROM AFFECTING THE CORES BY MEANS OF THE BED SPRING SHOWN IN THIS ILLUSTRATION

The daily production consists of approximately 650 motor castings, although the regular molding schedule calls for something over 800 motors a day. The specifications call for cylinders having walls only 5/32 inch thick. In order to withstand the high pressure of explosions, a special mixture of cast iron is used. About 12½ per cent of steel is added to the

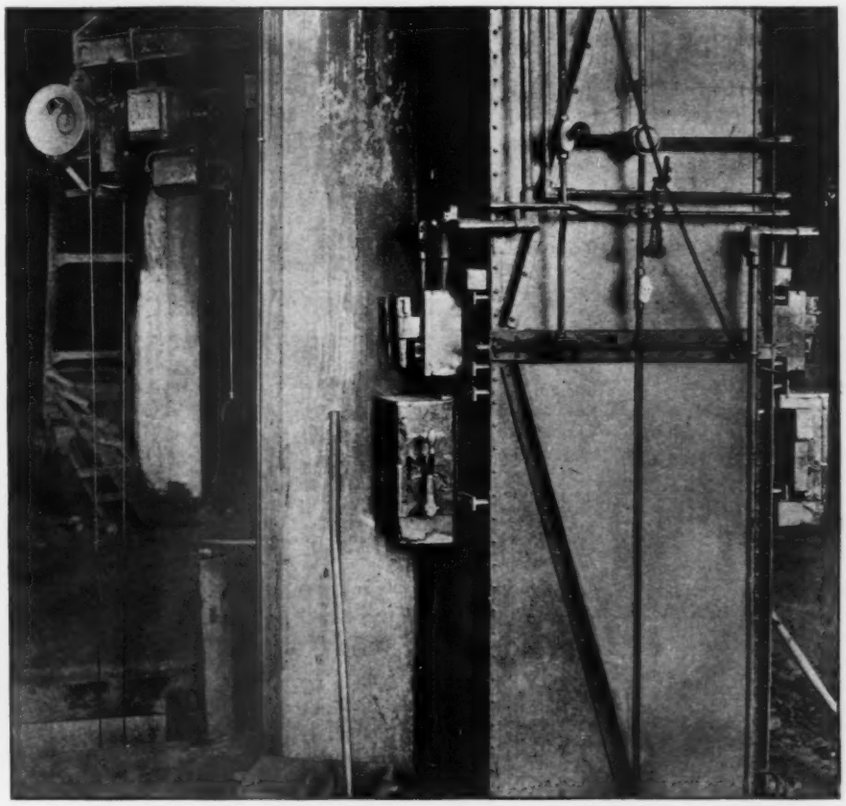


FIG. 13—THE BOX-SHAPED COLUMN AT THE RIGHT CONTAINS THE MOLDING SAND ELEVATOR; OTHER MATERIALS WHICH DO NOT PASS THROUGH THE SIEVE ARE HANDLED BY MEANS OF THE ELECTRIC HOIST SHOWN AT THE LEFT

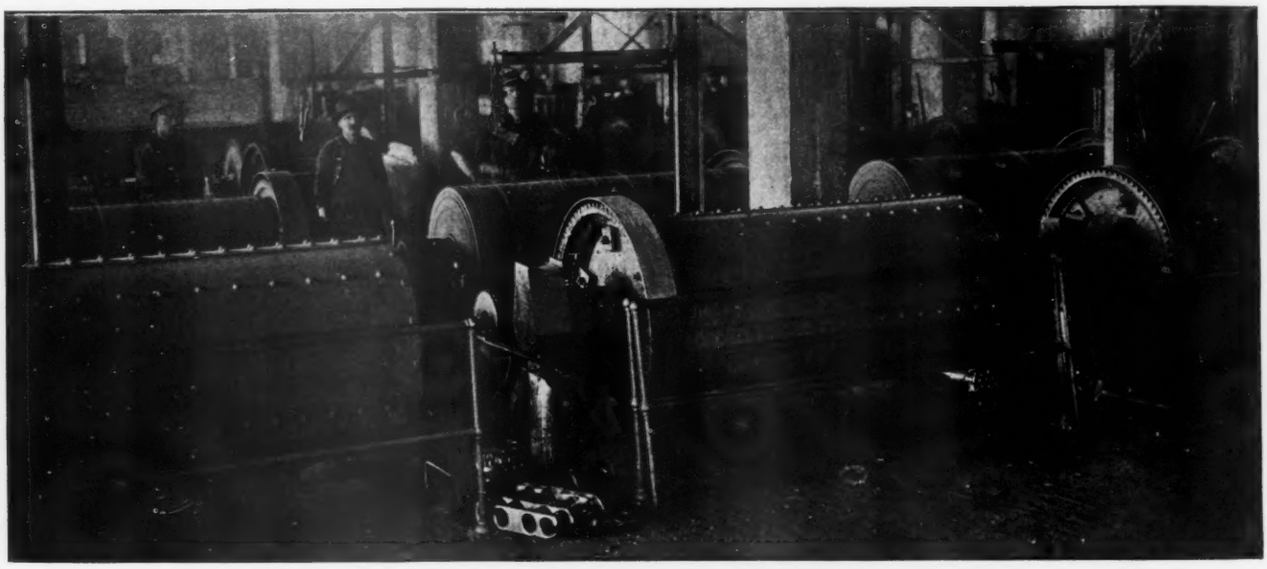


FIG. 14—A VIEW IN THE CLEANING ROOM SHOWING THE UNUSUALLY LARGE NUMBER OF TUMBLERS USED

mixture. A special grade of low phosphorus iron is used and the resultant metal contains from 2.15 to 2.25 per cent of silicon and the usual amount of sulphur and manganese. Tests of the metal are made hourly and a Keep machine is used to determine the strength of test bars. The strength of the ½-inch test bars, on the average, is about 550 pounds.

Making the Cores

The core room in an automobile foundry is one of the most important factors involved in its success. In the new Buick plant an unusually large amount of floor space has been allotted to the core department. The machine, core oven, and storage equipment is situated in the south end of the building on the second floor. At the southwest corner is a large room, in which 75 women are engaged in making cores.

The methods employed in the core department of the Buick Motor Co. are unusual and extraordinary precautions are taken to insure perfect cores. After the cores have been made, they are smoothed-up to exact size in rubbing jigs. They are then taken to finishers, who scrape them. After the cores are finished in this manner, they are taken to the assemblers, and are then oven-dried and inspected.

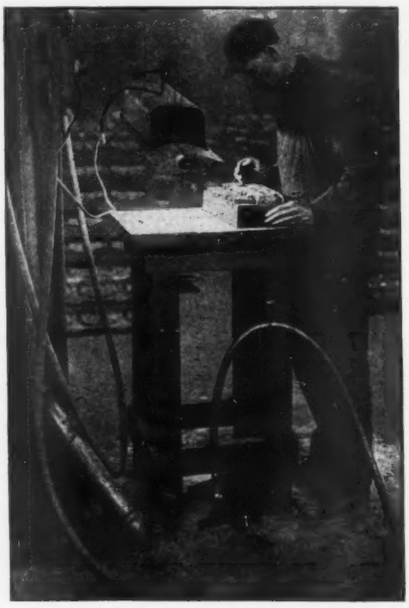


FIG. 16—CORE INSPECTION TABLE

Core Shop Equipment

The core oven equipment is unusually extensive, including a conveyor type of oven made by William Demmler & Bros., Kewanee, Ill., and eight-drawer and 24-car type ovens designed by the H. M. Lane Co., Detroit. The continuous conveyor oven is shown in Fig. 8. Cores to be baked are placed on steel racks, which are handled by storage battery charging trucks made by the Automatic Transportation Co., Buffalo, N. Y.,

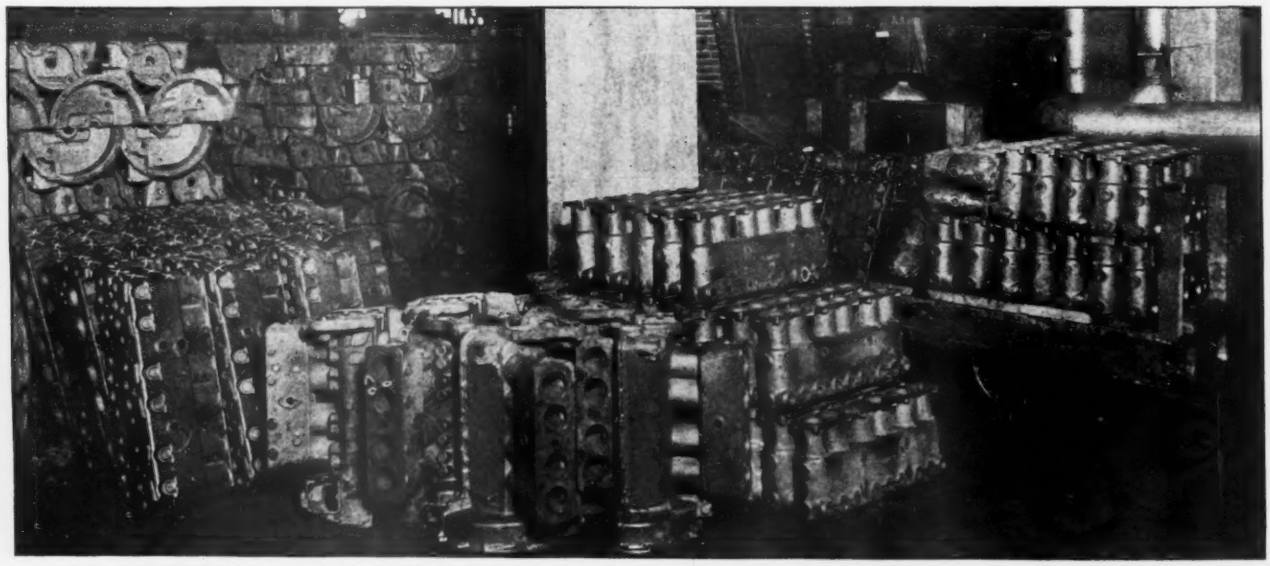


FIG. 15—A CORNER OF THE SHIPPING ROOM SHOWING A LARGE NUMBER OF MOTOR CASTINGS READY FOR SHIPMENT

and the Elwell-Parker Electric Co., Cleveland. Heat for the car and drawer type core ovens is furnished by means of furnaces situated in the basement under the first floor. These furnaces, which were designed by the H. M. Lane Co., Detroit, are coke-fired and supply a large volume of hot air, which is maintained at a constant temperature of 450 degrees Fahr. The core ovens are equipped with electric pyrometers made by the Brown Instrument Co., Philadelphia.

As the cores pass from one stage of completion to another, they are frequently stored on steel racks manufactured by the Durand Steel Locker Co., Chicago. These lockers are clearly shown in Fig. 11, which also indicates how the cores are dipped for blacking.

The finishing and inspection of certain kinds of cores is greatly facilitated by means of the inspection table, shown in Fig. 16. It will be noted that the lamp, which is made by the Cooper Hewitt Electric Co., Hoboken, N. J., throws a white light directly upon the work, enabling the inspector to easily detect defects in cores. The air hose shown in the illustration is provided for blowing loose particles of sand from the recesses of the cores.

Fig. 12, which illustrates the type of hand truck used in conveying cores from the core room to the molding floor, indicates how the common bedspring has been utilized advantageously in the foundry. It was found that in carrying cores on trucks, the jolting resulting from the pounding of the wheels on the hard floor, had a detrimental effect on the cores. To overcome this difficulty, the bed-springs were introduced, and the upper tables, on which the cores rest, were prevented from swaying sideways by means of wooden guides placed at either end of the trucks, as shown in the illustration.

Shaking-Out the Castings

After the molds have been prepared, the cores placed in position, and the metal poured and set, the sand is shaken-out. The castings are lowered through rectangular holes in the molding floor, which open into a number of chutes, some of which are shown at *B, B,* in Fig. 10. These chutes lead to benches built about 2 feet above the first floor, as shown in the illustration. As the castings slide to these benches, they are placed in large, rectangular-shaped boxes, which are later carried to the cleaning room by means of telpher cars.

The cleaning room occupies the southeast corner of the first floor of the foundry. The equipment in this department is unusually extensive and modern, and includes about 20 cylindrical tumblers of large size, seven smaller cylindrical tumblers, six tumblers of the box type, and four horizontal table sand blast machines, all manufactured by the W. W. Sly Mfg. Co., Cleveland. Dust arresters for the cleaning room apparatus were installed by the W. W. Sly Mfg. Co., and by the Central Iron Co., Quincy, Ill. The grinding equipment consists of a horizontal grinder, made by the Gardner Machine Co., Beloit, Wis.; a number of double-stand grinders, made by Frederick B. Stevens, Detroit; grinders made by the Detroit Emery Wheel Co., Detroit, and a number of swing grinders. The tumbler equipment is served by 2-ton electric hoists made by the Sprague Electric Works, New York, and pneumatic hoists made by the Curtis Pneumatic Machinery Co., St. Louis, Mo. Fig. 14, which is a view of the tumbling equipment, shows the extensive amount of apparatus required in the cleaning department.

After the castings have been thoroughly cleaned, they are placed on test racks and subjected to hydraulic pressure for leaks. The handling of the castings to and from the test racks, is facilitated by gravity carriers made by the Mathews Gravity Carrier Co., Ellwood City, Pa. After the test, the castings pass to the southwest corner of the foundry building, which serves as the shipping department. Fig. 15 shows a group of automobile castings ready for shipment.

It will have been noted in reading the foregoing account of the equipment and features of the Buick foundry that this plant has been especially designed for the mass production of castings in an economical manner. That good lighting and ventilating was an important consideration, is indicated in Fig. 1, which clearly shows the concrete and steel construction and the large proportion of the side and end walls consisting of steel sash. The roof construction is of the type know as the Pond truss, in which the cupola takes the form of the letter *M*. It will be noted that the wide span of the building has the effect of making the M-shaped cupola of unusually large dimensions, enabling the design and construction of three tiers of permanent sash in the cupola walls. These sash are operated by means of special sash operating gears shown in a number of illustrations containing interior views of the foundry. The Pond truss, the steel sash and operating gear were manufactured by the David Lupton's Sons Co., Philadelphia.

The floors are concrete throughout, except some portions of the cleaning room on the first floor, which are made of creosoted wood blocks. The building is heated by means of radiators placed at convenient points on the walls and ceiling. The radiator equipment was manufactured by the American Radiator Co., Chicago. Artificial lighting on the second floor is provided by means of Cooper Hewitt lights arranged twelve in a row across the building. Incandescent electric lamps are used in other parts of the building. The plans for the new foundry were suggested by members of the Buick Foundry staff and by the H. M. Lane Co., Detroit. The plans were executed by the H. M. Lane Co., and the construction work was done by the A. J. Smith Construction Co., contractor.

Government Prices for Zinc

The following prices for slab zinc have been fixed by the zinc committee of the advisory commission of the Council of National Defense and have received the approval of the government: Grade A, 11½ cents per pound; grade B, 11 cents, and grade C, 9 cents. The price of grade C is protected against decline. These prices are in carload lots, with freight allowed to New York delivery rate points. At the time when these prices were made, grade A sold in the open market at 18 cents and grade C has sold as high as 27½ cents per pound during the past year.

Rennerfelt Furnaces Sold

The sale of 17 additional Rennerfelt electric arc steel melting furnaces is reported by Hamilton & Hansell, New York City. One of these furnaces will be installed by the Central Steel Co., Massillon, O., for melting ferro-manganese, which will have a capacity of one ton and a 1,000-pound furnace was sold to the Chili Exploration Co., New York City. The remaining 15 furnaces are for installation abroad.

The Foundry Appliances Co., Newark, N. J., has been incorporated with $15,000 capital to engage in the manufacture of foundry appliances and supplies. Ernest M. Tapner, Newark; Charles J. Helligas, East Orange, and Joseph D. Louden, Rozelle, are the incorporators.

The American Foundry & Equipment Co., Chicago, has been organized with $10,000 capital, by Richard Fitzgerald, J. C. Schwartz and L. J. Bretz.

R. B. Seidel, Inc., Philadelphia, manufacturer of crucibles, is making plant extensions at a cost of about $3,000.

The Electric Furnace in the Steel Casting Plant

Details of the Practice Pursued in the Foundry of the Michigan Steel Castings Co., in the Production of Parts Averaging About 20 Pounds

By R F Flinterman

"SMALL Steel Castings" is the term applied to castings used for the most part for automobile trucks, tractors, light machinery parts, and for other purposes, where the size and shape of the part, its lightness of section or difficulty of production preclude its being made practically in open-hearth foundries. In the latter, the work is largely a tonnage proposition. The work is much heavier and on the whole simpler and the methods used cannot be applied successfully to the manufacture of lighter and more intricate castings.

The castings made in the plant of the Michigan Steel Castings Co. vary in weight from ½ to 250 or 300 pounds. Some pieces running up to 2,000 pounds are made; but the average weight is about 20 pounds.

Before installing the electric furnace a crucible furnace was used. This was chosen because of the low first cost of installation and also because of the generally accepted fact that crucible castings were of very high quality.

Crucible Process

The great difficulty with the crucible process was in the crucibles themselves. An average of three heats was considered good and at that rate meant about one cent added to the metal cost. Many crucibles would not come up to this average, and in order to save them as much as possible the final addition of ferro-silicon and ferro-manganese was cut down to a minimum. The result was a steel of low manganese content, about 0.4 per cent, and as a consequence a steel which was not always deoxidized. The inability to keep the carbon low, because of the absorption of carbon from the crucible was an added aggravation.

The second method was the side-blow converter. Its advantages over the crucible are:

Large unit of capacity, converters of one-ton and two-ton capacity being used.

The metal was uniformly hot and fluid and of fairly regular analysis.

Possibility of increasing manganese content and consequently getting very much better results on physical tests.

Great reduction of metal cost. The cost varied little from month to month.

The third and likely final choice was the electric furnace. The first furnace, a 6-ton Heroult, was installed in November, 1915. The second furnace of 3 tons capacity was ready to run Feb. 12, 1916. Both furnaces have been running continuously since their installation. It required several months to adapt the electric furnaces to shop conditions. This has, however, long since been accomplished and the furnaces have come up to expectations most completely.

Quality of Electric Steel

As regards the quality, the author believes that there is no question of the superiority of electric steel. In the converter at the end of the blow there is a mass of metal at a high temperature, covered by a highly oxidized slag and the metal itself undoubtedly contains oxides. The addition of ferro-silicon and ferro-manganese at this point deoxidizes the metal more or less completely, but the metal is still in contact with a slag carrying a high percentage of iron oxides, etc.

In the electric furnace the covering slag is completely deoxidized before ferro-silicon and ferro-manganese final additions are made. The metal is constantly giving up oxides to the slag during the deoxidizing period and is practically free from oxides before the final deoxidizers are added.

It is thought that the more complete absence of oxides in the electric steel accounts for its superiority. The results obtained on physical tests are universally better. Typical results are as follows:

	1	2	3	4
Max. strength, lbs.	66,750	76,000	62,400	69,000
Elastic limit, lbs..	42,500	45,000	36,500	37,800
Per cent reduc. in area	51.7	45.8	50.0	40.0
Per cent elongation in 2 inches.....	35.0	30.0	32.0	28.0
Silicon	0.23	0.20	0.27	0.33
Sulphur	0.025	0.021	0.043	0.050
Phosphorus	0.044	0.040	0.036	0.056
Manganese	0.74	0.64	0.52	0.70
Carbon	0.19	0.23	0.19	0.24

Steels Nos. 1 and 2 are from the basic furnace and Nos. 3 and 4 are from the acid furnace. The basic steel averages slightly higher than the acid steel.

The superiority of the electric steel lies in the fact that these results can be consistently obtained from every heat which was never possible in our other practice. Physical tests have been made on 30 consecutive heats and for every heat we have obtained results corresponding to the tests given. With the converter steel difficulty was experienced in maintaining an average reduction of area of 25 per cent and the elongation was usually about 20 per cent.

The superiority of the electric steel was also manifested in the case of long, thin-section castings, such as cross-members on engine supports. The loss due to shrink tears was much reduced with electric steel. On one particular pattern 100 castings were made from electric steel and no shrink tears were found. With exactly the same practice and pattern, 90 out of 100 castings made from converter steel had slight tears or cracks, which had to be welded in order to save the castings. This particular casting was very difficult to make and was perhaps an extreme case, but the test made brought out this difference in behavior most vividly.

Low Sulphur Content

This behavior is due to the lower sulphur content of electric steel and the absence of impurities, particularly of oxides. This resulted in much greater strength at high temperature and this greater strength was able to resist the pull, exerted on the steel during that period, when the castings were shrinking or shortening. This behavior of electric steel was true with both acid and basic steel, particularly with the latter, when a lower sulphur could be maintained.

It was particularly pleasing to have the high quality steel without any increase in cost. Under present market conditions, with low phosphorus pig iron selling at an exorbitant price, electric steel can be produced at a lower cost than with the use of this pig. As practice improves, electric steel manufacturers feel that their product can compete with that of any other process, under normal market conditions.

From a paper presented at the meeting of the American Electrochemical Society at Detroit, May, 1917. The author is president and general manager of the Michigan Steel Castings Co., Detroit.

At the present time the Michigan Steel Castings Co. is using acid linings and bottoms entirely. The reason for abandoning the basic process was the high and prohibitive price of magnesite. The company was a new consumer for this refractory and had not been able to secure a large supply, since the dealers were loathe to take on new customers and it became necessary to resort to acid practice.

This experience has been most valuable since one very great advantage was found in the acid process. One great difficulty with the basic process is the slag. The metal was poured from the furnace into a large coffee spout ladle in which the metal was taken to the pouring floors. The metal was poured through a spout into hand shanks, from which it was poured into molds. In all cases the metal was skimmed by means of a metal rod skimmer, while it was being poured into molds, in order to keep all slag back and prevent its entering the molds. In spite of all precautions there was much more trouble from slag in the castings than we had ever had from converter steel.

With exactly the same methods this slag trouble disappeared with the change to acid steel. This was due to the greater refractoriness or higher melting point of the siliceous slag, which brought about a more complete separation of the slag from the metal.

The basic metal acted at times as though there were actually present in the metal a small amount of slag in solution which slag would finally separate as the metal lost its heat. In a number of tests which were made when special precautions were taken to remove slag from metal, during the pouring of molds, we still found slag spots on the machined surfaces of the castings.

Reversed Duplexing Process

As already stated, with acid steel there was a minimum of slag trouble. This has led to the conclusion that an ideal arrangement for a steel foundry would be to use a "reversed duplexing process", as it were. Part of the metal should be melted in a basic furnace, where the metal would be refined and sulphur and phosphorus eliminated in the usual way. The stock used in this furnace should be of a much cheaper grade and would more than offset the increased cost of rehandling the refined metal through the acid furnace as the next step in the operation.

In the meantime, the acid furnace has been working on a partial charge of steel, to which when molten will be added the refined metal from the basic furnace. The final deoxidation under an acid slag can then be completed and metal withdrawn in the same manner as is done now. The author believes fully that this "reversed duplexing" can be so timed and manipulated in two or more furnaces that the ultimate output of the battery of furnaces will be the same in any given period as though the furnaces were all running either basic or acid independently.

Advantages of Duplexing

This method of "reversed duplexing" would have the following distinct advantages for the producer of steel castings:

1. The cost of part of the raw material would be much lower, since a high sulphur and high phosphorus stock can be used, as for instance screw machine turnings, which bring a low price on the market and cannot be used in acid practice.

2. The basic furnace could be run at a lower temperature during refining period and the life of roof and walls would be much prolonged. The final temperature could be attained in the acid furnace, where there is no difficulty in securing necessary temperature and fluidity without injury to lining. We have run up to 300 heats without repairing roof or lining.

3. It would be possible to obtain lower sulphur and phosphorus in the acid steel without increase in cost, in fact the finished cost might even be less.

4. The metal would receive final deoxidation under an acid slag. The advantage of this acid slag has already been emphasized, particularly the fact that the slag is more refractory and separates more completely. There is one further advantage. When the furnace contents are poured into the large ladle, the latter is immediately covered over with a congealed heavy slag crust, which keeps the air away from the steel and also keeps the steel hot longer. This is of great help in pouring a large variety of small castings, when fluidity and high temperature are most essential.

The author believes this "reversed duplexing process" may be of great value in other products such as tool steel, piano wire, etc., where the absence of even minute slag particles is most desirable. It would be interesting to conduct a comparative test on the products named above, made in the ordinary way and made by this double process. The suggestion may not seem so far-fetched when one bears in mind the fact that the higher grades of steel wire were until very recently made by crucible process, and in this process the slag was essentially an acid slag. How much of the quality possessed by these steels was due to the acid slag?

One other advantage of the electric furnace should be mentioned, namely, its great usefulness in making any of the alloys. This has been demonstrated by the constantly increasing adoption of the electric furnace by tool steel producers and other makers of special steel. This same advantage can also be put to use by manufacturers of steel castings in the production of alloy steel castings.

The author's experiences in making alloys by other processes was most unsatisfactory, since we were unable to obtain consistent results. This was due, no doubt, to the highly oxidized slag and presence of oxides in the steel itself, so that in many cases the alloying metals were oxidized and would be present in the final metals in varying and diminished quantities. With the electric steel the results have been more gratifying. We have been able to obtain any desired analysis regularly, and in consequence the subsequent heat treatments have given us the high physical qualities which we were after. This opens up a large new field for the maker of small castings, since there is a large demand for alloy castings for certain purposes, where lightness and great strength and thoroughness are necessary.

Every producer of steel castings wishes that this might be true. Without doubt the electric steel is purer and in consequence has within itself a minimum of impurities which during the transition from the molten state to a solid mass, would assume a gaseous form and cause blow-holes. This much is granted as true. But, nevertheless, there is just as much cause for presence of blow-holes in electric steel where the metal is poured into molds, as when the metal is made by other methods. The cause for such blow-holes is not inherent in the steel itself, but is due to the methods of making the molds and preparing them for the steel.

Importance of Molding

Just as much care must be used in molding to make a good casting, in order to maintain in the casting the high quality and strength possessed by the electric steel. Perhaps even greater care and vigilance must be used because of the very high temperature at which the steel is delivered from the electric furnace.

The electric furnace is not a cure-all for all foundry woes and troubles. To make a superior casting, the electric furnace metal must have a perfect mold, prepared with every possible care and attention to detail, properly gated, properly fed and properly vented. When such a happy combination has been properly brought about, the resultant casting will be satisfactory.

A Difficult Bronze Casting Molding Job

By Charles Vickers

ANY bronze or copper casting that is chambered-out by a relatively large core having few and small prints, is difficult to make. As a rule, the pattern is not constructed to facilitate molding in a way that will insure a sound casting and, furthermore, more than the ordinary amount of skill and planning ability is required to obtain satisfactory results.

The casting to be described is a water-cooled ring that constituted a part of the equipment of an electric furnace. Several brass founders failed in its production because they insisted on molding it the way the patternmaker thought it should be made, with the outlet cores in the drag of the mold. One foundryman tried the job seven or eight times before he gave it up as a failure and there is little doubt but that he could have made seven or eight more attempts with the same result, had it been possible to allow the pattern to remain with him that long. This reference is not made with the view of casting reflections upon this foundryman, but to dissuade others from trying to handle castings of this type in this manner.

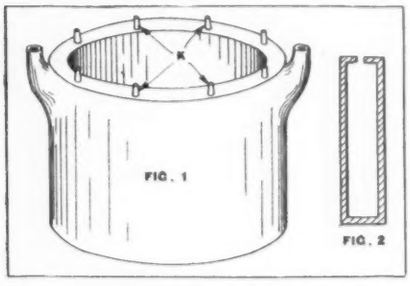


FIG. 1 — PATTERN FOR A BRONZE, WATER-COOLED RING. FIG. 2—CROSS-SECTION SHOWING RELATIVE METAL THICKNESS

The pattern is illustrated in Fig. 1, one of the cores in Fig. 3, and Fig. 2 is a cross-section of the casting through one of the vents. The two curved projections on the pattern are the water inlet and outlet; the small prints, *K*, Fig. 1, are ¾-inch in diameter and constitute the only means by which the core can be secured and provide the only outlet for the gases from the main core. The body core was made in four segments, one of which is shown in Fig. 3. These were provided with interlocking joints, two segments having the tongue on the inner part of the circle and two cores with the tongue on the convex side. The tendency of the four segment cores, when set in the mold, was to spring outwards. This was counteracted by a wire hoop bound around the body core and recessed into a groove. This tied the four segment cores into a strong, rigid ring. The wire is shown at *M*, Fig. 4, which is a diagonal section of the mold and clearly shows the runners and runner basins.

Patternmaker's Molding Method

The patternmaker planned to mold the casting with the prints, *K*, Fig. 1, in the drag, and the pattern was made and drafted accordingly. The first foundry that attempted the job experienced trouble from the start. Undoubtedly good castings can be made from the pattern as designed, nevertheless, the odds are overwhelmingly in favor of failure.

Let us consider what occurs in such a mold when the metal begins to enter. It fills the bottom in the form of a ring, encircling the slender core prints; fresh, hot metal continues to flow against them and as it rises it presses against the lower surfaces of the cores, and if these yield only slightly, the core rises and the metal flows around and underneath the core prints and up into the vents. The outlet for the gases is closed immediately, and as they gather force, disaster ensues. If the segment cores are held down by wires extending through the prints and are fastened to tie rods in the body of the core, there is always a chance that the fastenings may become loose, the tie rod used as an anchor may yield, or the wires may stretch under the strain. If the amount of yield is only 1/64-inch, the casting is a failure and is scrapped. It is possible, of course, to hold the cores rigidly with wires and chaplets. In this case the vents are free, but are necessarily small to conform to the size of the prints. Then, if the metal is poured strongly, it rises around the core faster than the gases can escape downwardly through the small prints and some are trapped in the upper part of the core and escape through the core and through the metal thickness in the upper part of the mold. This results in a blown casting. If, on the other hand, the mold is poured slowly, some part may fail to run. We have made out a pretty bad case for this particular method of molding, but it is not exaggerated, as those who have had this sad experience know.

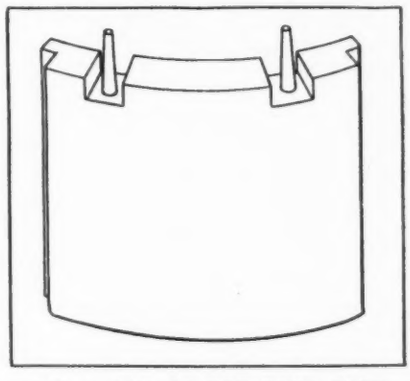


FIG. 3—ONE OF THE FOUR CORE SEGMENTS

The most satisfactory way to mold this casting is to suspend the core, as shown in Fig. 4. The core segments were suspended by thin wires which were doubled and one end of each was anchored securely in the core around the tie rods; the other ends extended up the vent channels in the main and small outlet cores, and projected about a foot beyond. The cores were made from an oil sand mixture, were well vented with cinders and were blacked with plumbago.

As the inside of the ring was lifted in the cope, it was necessary to pro-

vide a lifting ring, *D*, Fig. 4, to which prongs were attached to hold the sand at the sides; the lifting rods, *E*, were screwed into lugs cast onto the lifting ring. The upper ends of the lifting rods were provided with screw-eyes through which a bar was passed and wedged underneath, on top of the flask bars, as shown. In this way the mass of sand, from the cope bars to the bottom of the ring, was securely held.

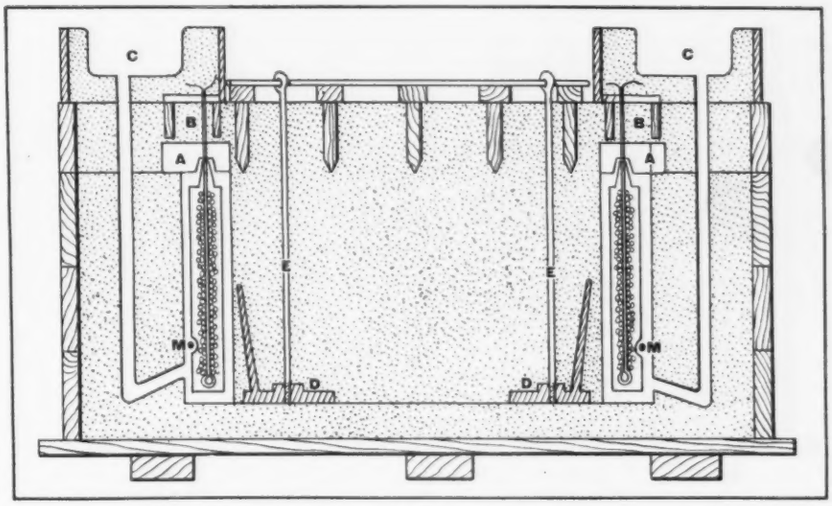


FIG. 4—DIAGONAL SECTION OF THE MOLD FOR THE BRONZE, WATER-COOLED RING, SHOWING THE METHOD OF GATING AND MOLDING. THIS RIGGING PREVENTED THE SHIFTING OF THE CORE

After the rigging was made, the actual work of ramming the mold was simple. A two-part flask was used, which consisted of a 6-inch cope and a deep drag. The pattern was placed core prints down on the follow-board, the drag flask was lowered, rammed and rolled-over and gates were provided in each corner of the mold. The outside of the ring was molded entirely in the drag with the joint flush with the upper part of the pattern, but the inside of the ring was parted at the bottom so that the green sand core formed part of the cope. The core was secured to the cope by the lifting ring and the screw-eyes. The cope lift was perfect, which was facilitated by the draft of the pattern which had been designed for molding the opposite way. However, in spite of this disadvantage, it would not have been possible to have obtained this result if the making of the mold had been in less skillful hands.

After the cope was lifted off, it was placed on high trestles so that the molders could work underneath, and the suspended green sand core was blacked and slicked, after which the core segments were placed in position. They were suspended by thin, double wires anchored in the body of the core, which passed up through the vents in the small cores that formed the outlets for the gases.

The ring core was held down with brick cores, *A*, Fig. 4, set over the core prints when molding the cope. The rectangular holding-down cores were recessed to fit over the core prints of the pattern and had vents passing through the top of the recess. They were rammed-up in the cope and were properly secured against a drop-out. When the ring core segments were set, the suspending wires were threaded through the vents in the holding-down cores and through the rest of the cope, having been secured to a rod laid across the flask bars by passing the wires on either side of it and twisting them together on top. The four core segments were bound together by a wire which was recessed in circumferential groove filed into the core, as shown at *M*, Fig. 4. The groove was filled with plumbago paste and the core was warmed with a gasoline torch. There was very little work to do on the drag after the pattern was drawn, except to black, slick and clean it out. The cope was tried on before permanent closure, but as everything had been planned carefully, there were no unforeseen occurrences. The mold was ready for the metal at the minute that had been specified, and there was no necessity for *holding* the metal in the furnaces. About 800 pounds were required to pour this casting. A ladle that held about 600 pounds and which was handled by a hoist, supplied the greater part of the metal. This was poured through one of sprues, while the opposite sprue was served by a crucible which held about 200 pounds of metal. While pouring, the runner basins, *C*, Fig. 4, were kept partially full of metal, and when the mold was filled they were about half full. No risers were provided and none were necessary. The metal in the basins was broken away while hot and after a suitable interval, the cope was removed and revealed what proved to be a perfect casting. This job again proved that careful planning and rigging are essential to foundry success, resulting from good molding practice. The work was done by William R. Marr, proprietor of the National Bronze Foundry, Niagara street, Buffalo.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Mine Pump Impellers

We would like a brass mixture suitable for brass impellers for mine pumps subjected to the corrosive action of mine water. We have been using a mixture consisting of 75 copper, 20 tin and 5 zinc, but this did not serve our purpose.

We believe the alloy would be too brittle for successful use in impellers. Zinc should not have been added to such an alloy, as it is impossible to obtain homogeneous metal with the percentage of tin stated. An alloy consisting of copper, 79.75 per cent; 15 per cent phosphor-copper, 0.25 per cent, and tin, 20 per cent, should be substituted in all cases where a hard mixture is desired that must sustain a high compressive load.

For bronze impellers we suggest the following alloy: Copper, 40.17 per cent; zinc, 37 per cent; tin, 0.25 per cent; 30 per cent manganese-copper, 17 per cent; nickel, 3.58 per cent, and aluminum, 1 per cent. Melt the copper, nickel and manganese copper together under charcoal, add the aluminum and stir thoroughly; follow with the zinc and the tin.

If a copper-tin alloy is preferred to the foregoing, use the following: Copper, 89.50 per cent; phosphor-copper, 0.50 per cent, and tin, 10 per cent.

Utilizing Scrap Babbitt Metal

We have accumulated about 600 pounds of cheap babbitt metal, which will grade about No. 4, and a small lot which will grade No. 1. We would like to make a good grade of babbitt metal from this material and we would like to have you advise us how we should proceed with this mixture. Also we would like to cast stock bushings for automobiles from red brass and we would like to know whether it is necessary to use a dry sand mold or whether a permanent mold is employed. The bushings are to be 1-inch outside diameter with a ½-inch hole bored in the center, and 12 inches long, while other bushings are to be 1¼ and 1½ inches in diameter with ½-inch openings.

The only satisfactory method of converting the babbitt metal is to melt it, mix it thoroughly and make an analysis of the ingoted metal. From this analysis the desired formula may be obtained accurately. Any other method is guesswork and would lead to inferior results.

The stock bushings will have to be cast in sand molds made by a skilled molder. The permanent mold cannot be used to advantage in making such castings and we do not advise such experiments on account of their high cost. It is not necessary to use a dry sand mold since the ordinary method of green sand molding will yield excellent results. The cores must be stiffly rodded to prevent bending them by the hydrostatic pressure of the metal. The castings should be poured horizontally and should be gated at a number of points so that the metal will positively fill the mold.

Difficulties in Casting Bronze Bushings

We are experiencing some difficulty in casting bronze bushings, which develop pit holes after cleaning, some of which extend into the metal as deep as ⅛-inch. These bushings are 2 inches in diameter with a 1-inch core, 1½ inches in diameter with a ¾-inch core, 1 inch in diameter with 1½-inch core and 12 inches long. They are molded vertically and are poured from the top through one gate. The metal was melted in a 40-pound pot in a coke-fired furnace and was kept covered with charcoal. The metal was ready to pour in 1¾ hours after the fire was started. We use a mixture of salt and borax as a flux and skimmed the metal once when in the fire and twice after its removal. We believe that this pitting is due to oxidation, but we are unable to trace the cause. Kindly let us know whether the time of melting has anything to do with our trouble.

The time of melting will not affect the quality of the metal provided it is protected from oxidation during the time it is in the fire. We fail to connect the pitting of the surface of the castings with the oxidation of the metal and we believe it to be due more probably to the use of molding sand of a poor quality and ramming the mold too firmly. Better results would be obtained by molding the bushings so that they can be cast on an incline with the gate at the upper end, the core being made rigid by a stiff iron rod embedded therein; the cope and drag of the mold should be thoroughly vented by the use of a knitting needle after ramming and before the cope is removed.

Bronze Mixture to Resist Acetic Acid

Kindly furnish us with a bronze mixture which will resist the action of acetic acid. The castings are to be used for bungs for vinegar barrels and the mixture, therefore, must contain no ingredient which will form a chemical reaction with the vinegar.

Any alloy containing copper, in time, will be attacked by the acid, resulting in the formation of copper acetate. If bronze must be used in this case, the following alloy might be employed if not too expensive: Copper, 90 per cent, and tin, 10 per cent. The castings should be coated heavily with tin on the surfaces exposed to the action of the vinegar.

Analyses of Bearing Metals

We would like to have analyses of four anti-friction bearing metals to be used for the following purposes:

Heavy duty and high speed engines, motors and generators, for passenger and freight car service, etc.

Heavy duty and low speed bearings, such as are used on rolling mills, heavy duty, low speed engines, rock crushers, etc.

Light duty and high speed bearings for cream separators, automobiles, aeroplanes, small motors, blowers, grinders, planing mill machinery, etc.

Light duty and low speed; these bearings are intended as an ordinary metal for light, low speed machinery.

The following alloys, in the order in which the inquiries are made, will meet the requirements stated:

Tin, 83.5 per cent; antimony, 11 per cent, and copper, 5.5 per cent.

Tin, 60.75 per cent; antimony, 10.5 per cent; lead, 25 per cent, and copper, 3.75 per cent.

For the last two classes of bearings, the following will give good service:

Lead, 80 per cent; antimony, 15 per cent, and tin, 5 per cent.

Utilizing Thin, Rolled Brass Scrap

What mixture is used by mills for rolling sheet brass 0.01-inch in thickness and less? How can this brass be used in the form of scrap approximately ½-inch wide?

The composition of sheet brass may vary widely within a range of 60 per cent copper and 40 per cent zinc, to 88 per cent copper, 10 per cent zinc, 1 per cent tin and 1 per cent lead. Its composition depends entirely upon the purpose for which the brass is intended. In this instance it would be safe to assume that the brass consisted of 70 per cent copper and 30 per cent zinc and that it can be used to advantage on this basis for adding zinc to any alloy of which this metal forms one of the ingredients. Also, it could be used for making yellow brass to which it would be advisable to add 2 pounds of tin and 2 pounds of lead to each 100 pounds of brass, in order to stiffen it and make it machinable.

Owing to the small particles constituting the scrap, it will almost be necessary to briquette it, as otherwise much of it will be lost in charging it into the crucible or furnace. The size of these briquettes will be governed by the manner in which the scrap can be used; if it is to be run down into yellow brass a large briquette can be used and a smaller one will be necessary if the brass is employed to carry zinc into a red brass alloy. If a cabbaging press or briquetting machine is not available, it is advisable to run the scrap into ingot molds, provided a large crucible is at hand for this purpose, as this thin scrap can be handled with a scoop shovel to fill the crucible after which the furnace can be closed to soften the scrap; after the scrap is softened it can be crushed down, fine charcoal added and more scrap charged, and this operation can be continued until the pot is full, when it can be pulled and the metal poured into ingots of suitable size.

White Brass for Automobile Door Handles

Can your furnish us with a mixture of white brass which is used at present for automobile door handles?

The following alloy is used extensively for this purpose: Copper, 49.85 per cent; nickel, 15 per cent; zinc, 35 per cent, and aluminum, 0.15 per cent. Melt the copper and nickel together, add the aluminum and stir well, following with the zinc. The latter is added gradually to avoid chilling the molten bath.

FORMULAS FOR THE BRASS FOUNDRYMAN

Strong Aluminum Alloys

The following alloy is used extensively in the manufacture of automobile pistons, aluminum worm wheels, and for all purposes requiring an alloy of more than the usual strength.

First make the following hardener:

Melt together under charcoal

	Pounds.
Copper	10
Nickel	1¼

When thoroughly fluid, add 5 pounds of aluminum in small pieces, and while the alloy is at a high temperature, add 3¾ pounds of tin plate and stir vigorously with a thin iron bar until all the tin plate is dissolved. The alloy should be thoroughly fluid, that is, no lumps should be located by the stirring bar. At this stage, add gradually 10 pounds of aluminum, making a total of 15 pounds of this metal; thoroughly stir the bath and ingot.

To make the aluminum alloy, place a crucible of suitable size in the furnace and melt therein 83½ pounds of aluminum; allow it to attain a very dull red temperature, then add 6 pounds of the hardener, and ½ pound of magnesium; stir well to insure the thorough incorporation of the added metals; follow with an additional 10 pounds of aluminum, making a total of 93½ pounds of this metal, 6 pounds of hardener and ½ pound of magnesium. The resulting alloy then will approximate the following composition by analysis:

	Per Cent.
Aluminum	95.98
Copper	2.00
Nickel	0.24
Iron	1.00
Silicon	0.40
Magnesium	0.38

When carefully made this alloy should possess the following physical properties:

Ultimate strength, pounds per square inch	27,000 to 29,000
Yield point, pounds per square inch	12,000 to 14,000
Elongation in 2 inches, per cent	3.50 to 4.00
Reduction of area, per cent	4.00 to 5.00

FORMULAS FOR THE BRASS FOUNDRYMAN

Aluminum Alloys Suitable for Drawing Into Wire.

Alloy A

	Per Cent.
Aluminum	98.40
Copper	1.60

To make the alloy, melt together 96.80 per cent of pure aluminum and 3.20 per cent of an alloy composed of 50 per cent copper and 50 per cent of aluminum.

Alloy B

	Per Cent.
Aluminum	97.70
Copper	1.00
Nickel	1.30

In making alloy *B*, first make a hardener, as follows:

	Per Cent.
Copper	20.00
Nickel	26.00
Aluminum	54.00

To make the alloy melt the following together:

	Per Cent.
Aluminum	95.00
B hardener	5.00

Alloy C

	Per Cent.
Aluminum	98.00
Manganese	2.00

In making alloy *C*, use the commercial alloy of manganese and aluminum which contains approximately 20 per cent of manganese and the balance aluminum. This is the safest method of making the alloy from the standpoint of the ordinary brassfounder.

Physical Properties

The physical properties of the foregoing alloys will be approximately as follows:

Alloy A

Electrical conductivity, 50 per cent of that of copper. Tensile strength, 39,000 pounds per square inch in wire.

Alloy B

Electrical conductivity, 49 per cent of that of copper. Tensile strength, 45,500 pounds per square inch in wire.

Alloy C

Electrical conductivity, 48 per cent of that of copper. Tensile strength, 35,000 pounds per square inch in wire.

THE FOUNDRY DATA SHEET, JUNE, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

The Evolution of the Die-Casting Process---I

A Discussion of Early Practice Underlying the Development of the Die Cast Part Which Has Attained a High State of Perfection

By Charles W Pack

FORMING various shapes of metal by means of the die-casting process is the outcome of a long series of developments in metal casting. The die-casting process as an individual industry dates back less than 25 years, but the fundamental principles were known as far back as the fifteenth century.

In tracing the advance in the metal casting art it is found that the methods used, even in the prehistoric ages, are being utilized today, and in studying metal founding of that time, we are obliged to seek information on the subject from the religious teachings laid down in the Bible; or we must investigate the scientific writings of many learned archeologists. The hieroglyphic inscriptions found in caves and dwellings of prehistoric men are the basis of much that has been written regarding the early forms of metal casting.

In the Bible we find many references to the casting of metals. The casting of the golden calf by Aaron is probably the most prominent and best remembered, although reference is also made to the casting of idols used by the Egyptians and other infidel races for worship. Aaron's work is described in the following words: "And all the people broke the golden ear rings which were in their ears and brought them unto Aaron. And he received them at their hands and fashioned it with a graving tool after he had made it molten calf." We also find that King Solomon's throne was adorned by two huge bronze lions and in many other instances there appear references to the casting of metal. The value of Biblical statements in scientific research has been questioned, but there are many facts that point to their probability.

Work of Egyptians

There seems to be little doubt that the ancient Egyptians were well versed in the art of metal casting and were also familiar with the basic metallurgical and chemical principles involved in the reduction of metals from their ores. If Aaron really cast the golden calf he undoubtedly learned the art from the Egyptians. It is unfortunate that no written history has been handed down from that ancient race since it is generally believed that they possessed a vast amount of metallurgical knowledge which was lost before history could record it.

In describing the royal tombs of the first dynasty of Egypt, dating from about 4000 B. C., William Flinders Petrie states "that gold hawks had been cast in a mold and the junction line carefully removed and burnished". This quotation by Petrie is of interest inasmuch as he claims that the Egyptians had been producing metal castings in the year 4000 B. C., which antedates the beginning of the Hebraic calendar by about 300 years and leads to the belief that the golden calf incident is worthy of serious thought.

From a practical standpoint, however, we are more particularly interested in the metals, alloys, fuels, furnaces and molding compositions used rather than the purely historical aspect of the subject.

Fig. 1 is reproduced from a wall painting in an Egyptian tomb and is dated 1500 B. C. From this picture it appears that the Egyptians first alloyed their metals and poured them into ingot molds. The furnaces of the most ancient type consisted merely of a hole dug in the ground to hold the crucible and fuel. In the picture one man is shown fanning the fire with a bamboo matting to create a draft. This picture appears to represent a forging rather than a casting shop. The metal was undoubtedly poured into the ingot molds, heated to the proper temperature and forged out to the various shapes. The figures in the upper part of the picture appear to be showing some of the forged implements.

Fig. 2 is also taken from an Egyptian wall painting and shows a more advanced method of creating a draft for the fire. Here the foot bellows seem to have been in use. This bellows was operated by two men alternately raising and lowering their feet. In the upper part of the picture one man appears to be stirring

Presented at the Cleveland meeting of the Institute of Metals, September, 1916. The author, Charles W. Pack, is with the Doehler Die Casting Co., Brooklyn, N. Y.

FIG. 1—EGYPTIANS CASTING METAL 1,500 B. C.

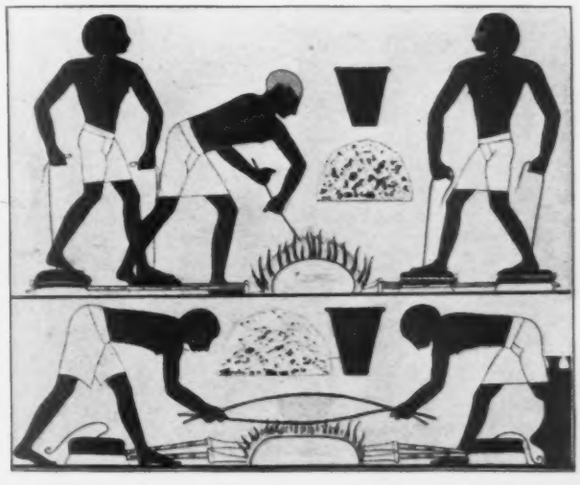


FIG. 2—EGYPTIAN FURNACE 1,500 B. C., SHOWING BELLOWS

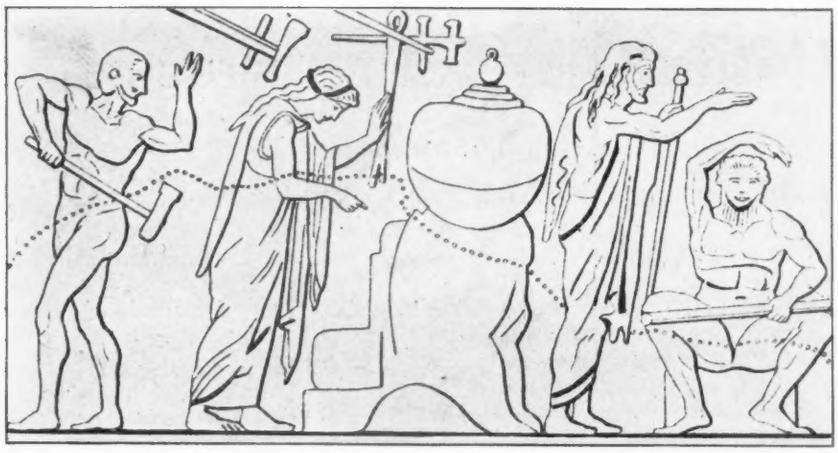


FIG. 3—DRAWING OF A GREEK FURNACE REPRODUCED FROM A VASE

the metal while in the lower part the men appear to be preheating the crucible preparatory to pouring.

Although the Egyptians practiced the art of metal casting long before any other nation, the Greeks were undoubtedly the most skillful in this art during the 10 centuries immediately preceding the beginning of the Christian era. One of the seven wonders of the world is the bronze statue of the sun god Helois, in Rhodes, commonly known as the Colossus of Rhodes, made by a Greek named Chares, during the reign of Demetrices in the fourth century before Christ. This work occupied him for 12 years and when finished stood 105 feet high, weighing 360 tons. The statue was destroyed by an earthquake in 224 B. C. The remains lay scattered for about 1,000 years and were then sold to an enterprising junk dealer who resold the bronze for the manufacture of war material. Other Greek colossi such as the Apollo of Calamis, the Zeus and Hercules of Lysippus and the Zeus at Olympia are among the most remarkable castings of any age. In 479 B. C. a bronze pillar was set up by the Greeks to commemorate their victories. It was about 20 feet high cast in one piece, hollow with the frame of the states engraved on it.

Greek Statue-Makers

Fig. 3 is reproduced from an ancient Greek vase and is believed to represent a statue-maker's shop, dated about 500 B. C. The furnace shown here is of a more advanced type than that used by the Egyptians, it being raised and allowance being made for draft at the bottom. A statue in the process of assembly is shown at the right of the picture and a number of the tools used are also in evidence.

Fig. 8, also taken from a vase of the same period, gives a better view of the furnace used and shows that they also used the fire box for annealing their ingot metals preparatory to hammering. The mallet, hammer and tongs are the same as those used at present.

A whole series of molds belonging to the twelfth dynasty of Egypt (about 2400 B. C.) has been unearthed. The molds were carved in thick pieces of clay, baked into pottery and lined with a fine ashy clay. In the lake dwellings of Switzerland have been found various molds of rock and clay which date from 1000 to 2000 B. C. Rock seemed to be preferred for the flat objects and clay was used for the more complicated molds. Whether the first molds were of stone or baked clay is uncertain since stone and clay were more closely related to the pottery art which is far older than recorded history.

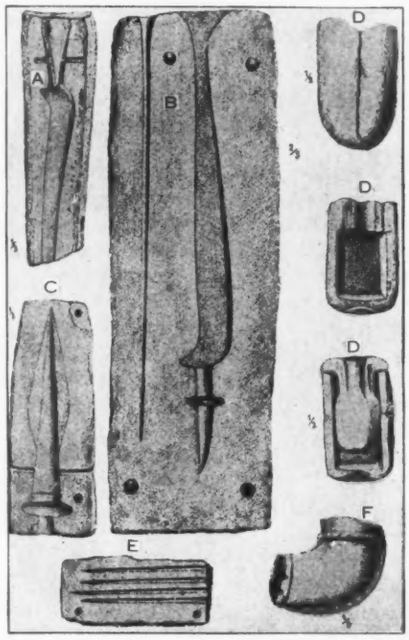


FIG. 4—STONE AND BAKED CLAY MOLDS

Rock and Clay Molds

Both rock and clay molds, or at least some of them, were constructed in halves or even more parts so that they could be preserved. Holes for plugs are to be seen which were used in fitting the parts of the molds together. Molds found in Troy likewise show the use of both stone and baked clay, some of them being constructed in symmetrical halves.

The stone molds shown in Fig. 6 were undoubtedly constructed in symmetrical halves and were used in casting swords at Troy. Fig. 5 shows terra cotta molds dated 1600 B. C. These molds probably were used for casting some offensive or defensive weapon of that age. Fig. 4 shows a number of stone and baked clay open and closed molds taken from the lake dwellings of Switzerland and dated 1000 to 1500 B. C.; *A* and *B* are sec-

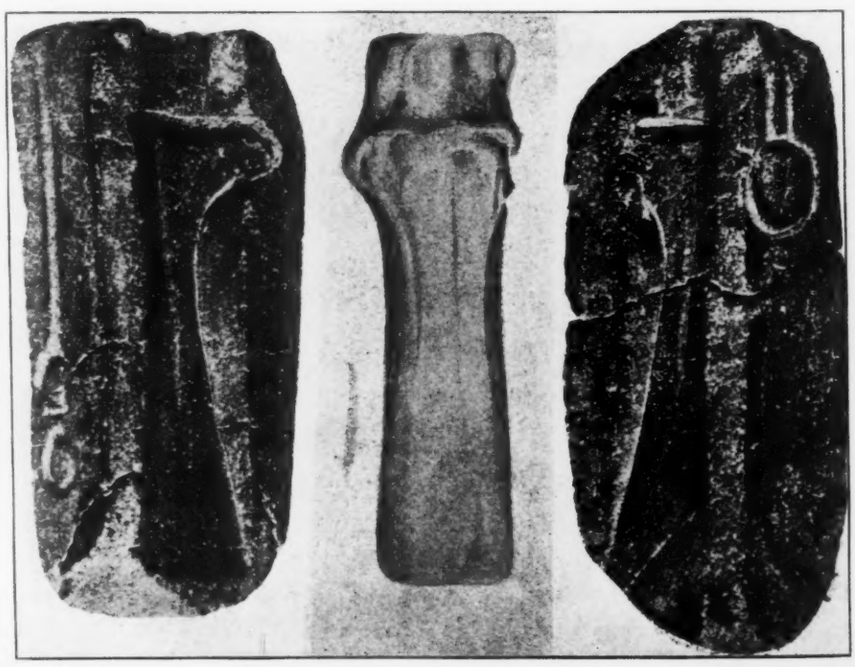


FIG. 5—TERRA COTTA MOLDS, 1,600 B. C.

tional views of sword molds, the latter showing dowel pins used for locating the two halves; *C* represents a mold used for casting spear heads, *D* shows a mold for casting hammer heads, and *E* is a mold for casting pins; *F* shows a closed mold for casting a curved part.

Before leaving the subject of ancient casting processes, the part played by Japan in developing the art of casting metal should be mentioned. Very little is known of the casting art as practiced in Japan because much Japanese history has been kept sealed from the civilized world by traditions which have only been laid aside during the past 50 years.

Fig. 7, copied from a print preserved in the Smithsonian Institute, represents the shipping department of a wire rolling, or more properly, a wire hammering shop. This shows the coils of wire, with an employe carrying a bundle evidently made from wire. Other parts of this print, not illustrated here, show the casting room which bears a remarkable resemblance to the equipment employed in modern brass casting plants. Other portions of this print also clearly outline the method of pouring the metal into small ingots which undoubtedly were hammered into wire. The operation of cutting the metal into strips also was performed by the Japanese.

FIG. 7—MEDIEVAL JAPANESE PRINT FROM THE SMITHSONIAN INSTITUTE

Metals and Alloys

The next subject with which we are concerned is that of the metals or alloys used in the prehistoric arts. Here again we must depend upon quotations of writers and upon the analyses of the few samples unearthed.

Science divides the human progress during the prehistoric ages into three groups—the stone age, the bronze age and the iron age.

FIG. 8—ANCIENT GREEK FURNACE FROM A VASE

FIG. 6—STONE MOLDS FOUND AT TROY

These ages cannot be distinctly attributed to any definite century or centuries since they varied in different parts of the earth in accordance to the degree of civilization. The end of the stone age and beginning of the bronze age is generally placed by various writers to be between 2000 and 3000 B. C.

Priority of Brass and Bronze

Although there is considerable discussion as to the priority of the iron and bronze ages, the writer believes that iron must have come before bronze, because it must have been discovered very early in the form of meteorites. It is also believed that copper was used before bronze since the former is found in nature ready for the hammer, whereas for the production of the bronze a reduction or alloying process is necessary. King, in his history of Sumer and Akkad, says of the Sumerians: "The art of casting in metal was also practiced by the Sumerians and even in the earliest period anterior to the reign of Ur-Nina (about 3000 B. C.) small foundation figures have been discovered which were cast in solid copper."

An analysis of the metal of such remnants shows that it was copper and not bronze, indicating that the latter alloy had not come into use in that district.

The question that next arises is the priority of brass or bronze in history To arrive at any satisfactory conclusion to this problem, we must ask ourselves "What is brass and what is bronze?" The British Institute of Metals appointed a committee in April, 1912, to define brass and bronze. This committee reported that brass was a

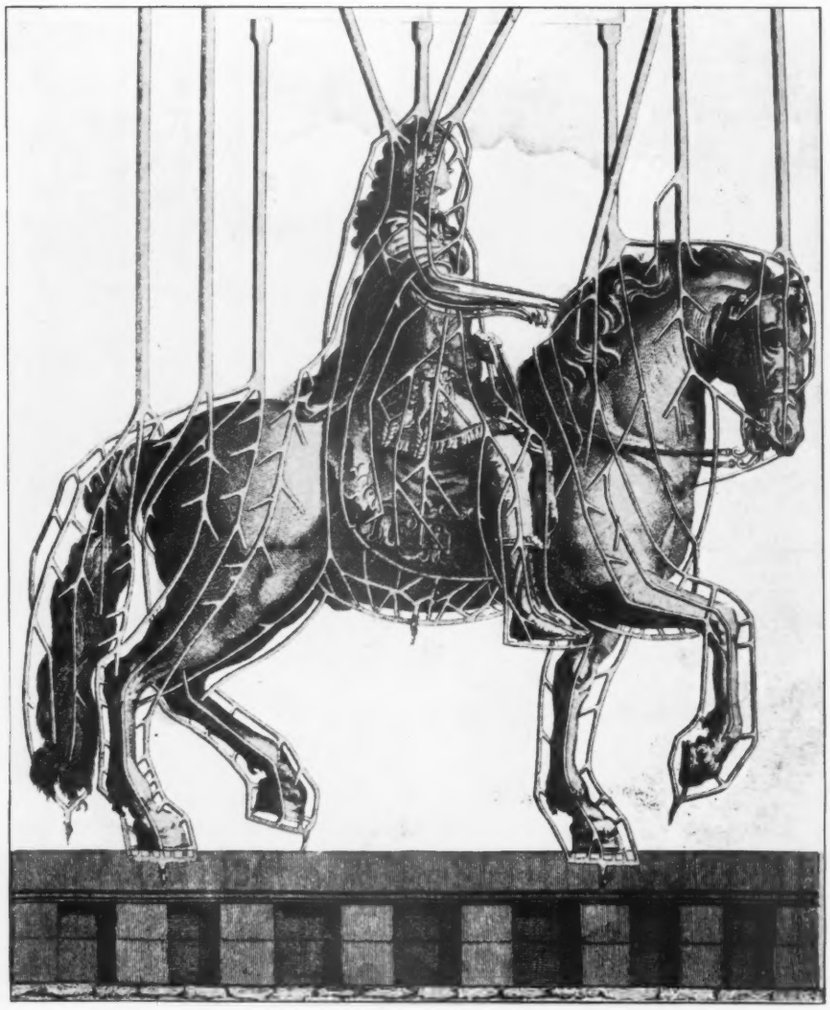


FIG. 9—CIRE PERDUE PROCESS, WAX FIGURE OF LOUIS XIV (1699)

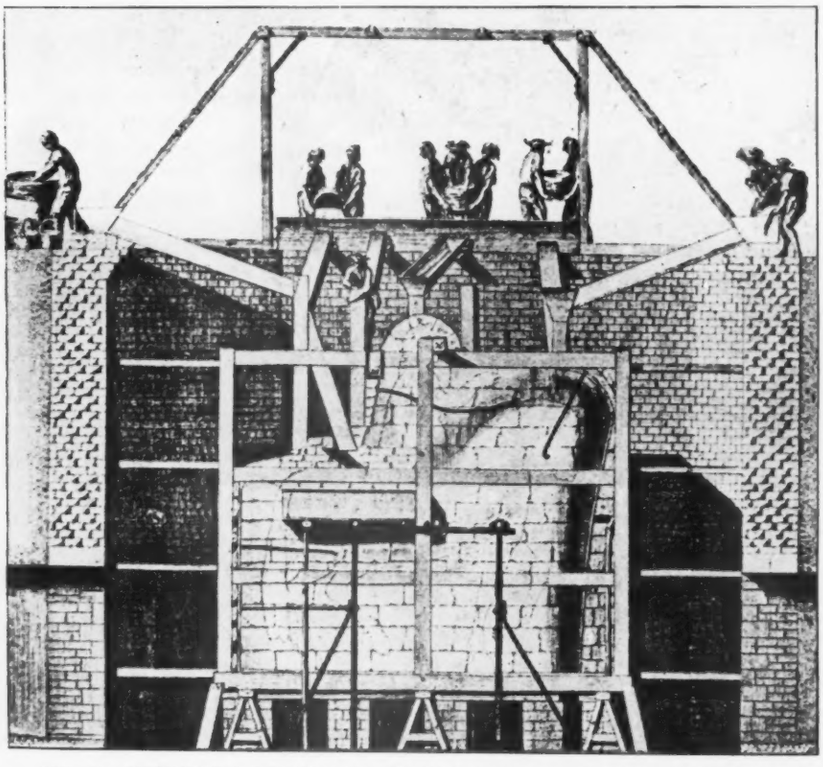


FIG. 10—SHOWING METHOD OF POURING EMPLOYED IN THE LOST WAX PROCESS

copper-zinc alloy having a copper content of over 50 per cent, whereas bronze was a copper-tin alloy also having a copper content of over 50 per cent. Nevertheless there are so-called bronzes on the market that contain no trace of tin, and others that contain as high as 40 per cent zinc. Assuming the definition laid down by the Institute of Metals, we are led to the belief that the bronzes or copper-tin alloys were cast long before the brasses or copper-zinc alloys. The Phoenecians brought tin from Cornwall in 1100 B. C., or before the building of King Solomon's temple. Hiram is said to have made articles of brass for the temple (1004 B. C.), but there is a dispute as to the terms of brass and bronze. Some editors of the Bible use the term brass and others the term bronze. Hiram procured his tin from Cornwall and his product was undoubtedly a bronze. The bronze was poured into molds and it is believed that the implements were tempered or hardened as desired. The ancient European bronzes which have thus far been analyzed show no traces of zinc, but contain tin in varying proportions, a few also showing lead and some lead and iron. The Chinese state that Yu, who was a semi-king with a partner Chun on the throne of China, 2200 B. C., caused nine vases to be cast of bronze on which were engraved maps of the nine provinces of the empire.

Use of Brass

Brass was known to the ancients as a more valuable kind of copper. The "Brazen Bull" was cast by Perillus, of Athens, 570 B. C. This was a statue made hollow to receive victims to be roasted to death. It is peculiar to note that the artist was the first victim and the king who condemned him was forced to try the experiment himself later. Brass was known during the classic Greek period as "orchalcum", or mountain bronze.

In the foregoing I have endeavored to give an outline of the status of the metal casting art up to and including the beginning of the Christian era. There began at this period a series of endless religious wars. Political conspiracies to satisfy personal ambition, coupled with sham religious doctrines, caused the wreck of the Roman empire, and turned the civilized parts of Europe, Asia and Africa into a seething caldron of religious fanatics whose only aim was to conquer and exterminate the conquered. Conditions during the tenth century became so bad and the outlook was so dark that the belief became prevalent that the world would come to an end during the year 1000. At this time all interest in life seemed to have been lost by the people. Build-

ings and artistic structures were allowed to go to ruin. It is surprising that under such conditions metal casting as well as the other arts should have deteriorated. Little or no progress seems to have been made up to the fifteenth century, and it is doubtful if the men living in this age were as well versed in the art of casting metals as the ancients. One of the few records concerning the art of metal casting during the dark or middle ages is given by Theophilus in his "Schedule of the Various Arts". His description of the casting of a silver vase follows:

"Take two pieces of iron, equal in length and width, the measure of a palm and the thickness of a straw, evenly beaten and without a flaw, and carefully smoothed with a plane. Make between these an iron binding, beaten smoothly and moderately thick, which you will bend in the fashion of a circle, of such a size as can apparently be filled with the silver you wish to cast in it. When you have bent it do not join the ends together, but separate them a little, giving an opening through which you can pour in the metal. Fit this circle equally between the iron plates with the ends a little beyond the irons and bind these with three strong iron hooks, below and on each side near the opening. Then plaster beaten clay around the circle between the irons and abundantly near the opening. When this mold has become dry, warm it and pour in the melted silver."

Introduction of Printing

With the introduction of printing by Gutenberg in 1454 the awakening began. Knowledge spread more rapidly than heretofore, and the result was that the spirit of progress so long dead sprang to life once more and led to various discoveries in the arts and sciences.

The discovery of the Cape of Good Hope, and later the discovery of America by Columbus during the fifteenth century, were sure signs that the march of progress had actually begun.

Metal casting progress after the fifteenth century may be attributed to the manufacture of art work, fire arms, industrial appliances and the development of printing.

The casting of fine statuary work, although an important industry today, does not receive as much attention as it did during the classic Greek period or even during the five centuries immediately succeeding the dark ages. It is doubtful if anyone could be found in this age of commercialism who would spend 12 years on a

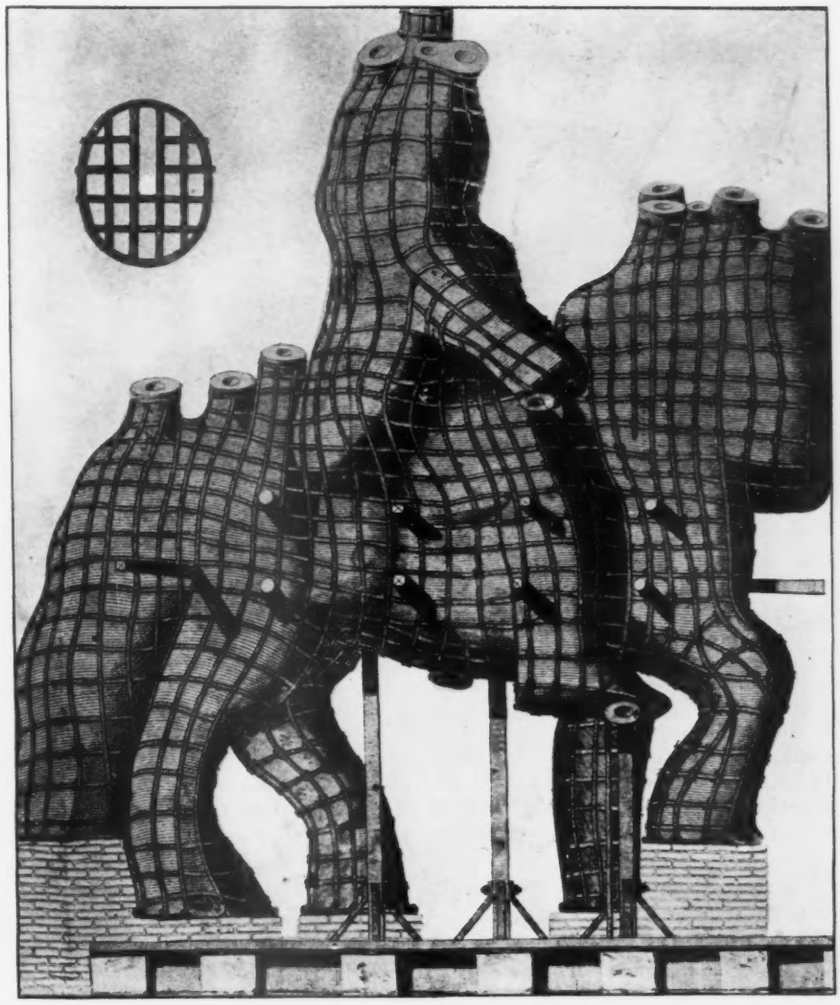


FIG. 11—CIRE PERDUE PROCESS, FIGURES COVERED WITH CLAY

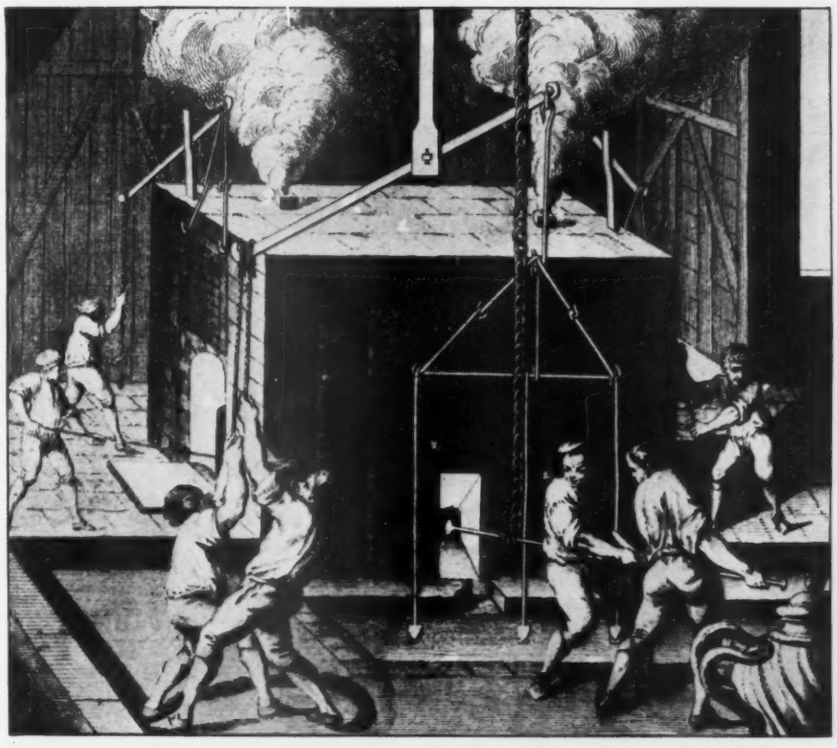


FIG. 12—VIEW OF FURNACE USED IN 1699

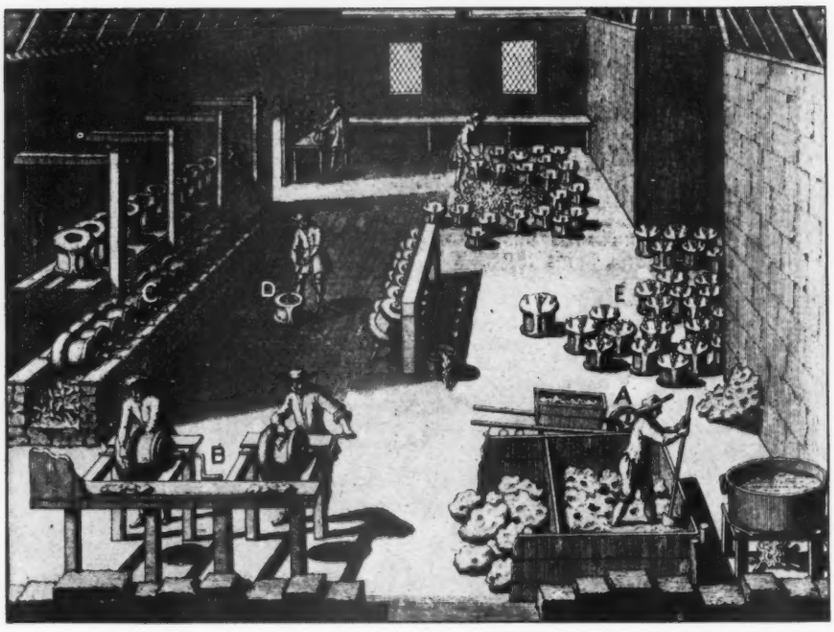


FIG. 13—PREPARATION FOR CASTING IN CLAY, 1718

single piece of work, as did Chares on his Colossus of Rhodes. The amazing amount of patience and labor put into the bronze statuary castings by the latter-day artists is vividly described by Cellini, one of the foremost artists of the sixteenth century, in his treatises, extracts of which will be given later.

The Lost Wax Process

The process used by Cellini was what is known as the *Cire Perdue,* or "Lost Wax Process". This process used extensively at the present time, in its simplest form consists in making a model of wax, surrounding it with suitable molding composition, baking to remove the wax and replacing the wax with metal, usually bronze.

Fig. 9, a reproduction of a picture dated 1699, shows the wax outline of an equestrian statue of Louis XIV. Cellini describes this step in the process very clearly as follows:

"I made a model in clay of just the size the figure was to be. This done, I estimated that the shrinkage would be about one finger thickness, so I very carefully went over the whole, touching it up and measuring it as the art directs. Then I gave it a good baking and after that I spread over the whole an even coat of wax of less than a finger thickness, similarly adding wax where I thought it needed it or even taking a little from off the waxen coat that was over the whole. This method I pursued with infinite diligence and care."

This photograph shows the attention given to gating and venting of the figure. All precautions were taken to insure the proper removal of the wax and volatile gases as well as the filling-in of the metal in every detail. The next step in the process was to coat the mass with clay or other material capable of withstanding the action of the molten bronze. The entire mass was then reinforced, banded with iron bands and otherwise supported to withstand the strain while the metal was being so poured. Fig. 10 shows the appearance of the mold ready for baking and subsequent pouring.

Mixing the Clay

The mixing and application of the clay used for the mold is also described by Cellini in his egotistic though inimitable way, as follows:

"I pounded up some ox bone, or rather the burnt core of ox horns. It is like a sponge, ignites easily and is the best bone you can get anywhere. With this I heat up half a quart of gesso of Tripoli and a quarter of a pint of iron filings and mixed the three well together with a moist solution of the dung of horses or kine which I first passed through a sieve of fresh water until the water took the color of the dung. The whole formed a composition which I applied to my model with hog sables, arranging the bristles so that their softer and outer ends formed the ends of the sables and were thus tender to work with. Thus I gave the whole figure an equal coating of the composition all over. Then I let it dry and similarly gave it two more coats each time letting them dry. These coats were about the thickness of the back of an ordinary table knife. This done, I gave it a coat of clay about half a finger thick, let that dry too, and finally a third coat of the same thickness."

Here Cellini digresses to explain about the clay. He says that the clay should have a certain sandiness. He further states that you should prepare it long before by sifting it carefully, mixing it with cloth frayings and with water to the thickness of a dough, beating it up and letting it decompose for at least four months.

The next step in the process was to lower the mold into a pit baking with a small fire so as to melt out the wax, care being taken to prevent it from boiling. The fire was then raised to drive off all moisture. It was then encased in bricks and clay and fired well until all organic mat-

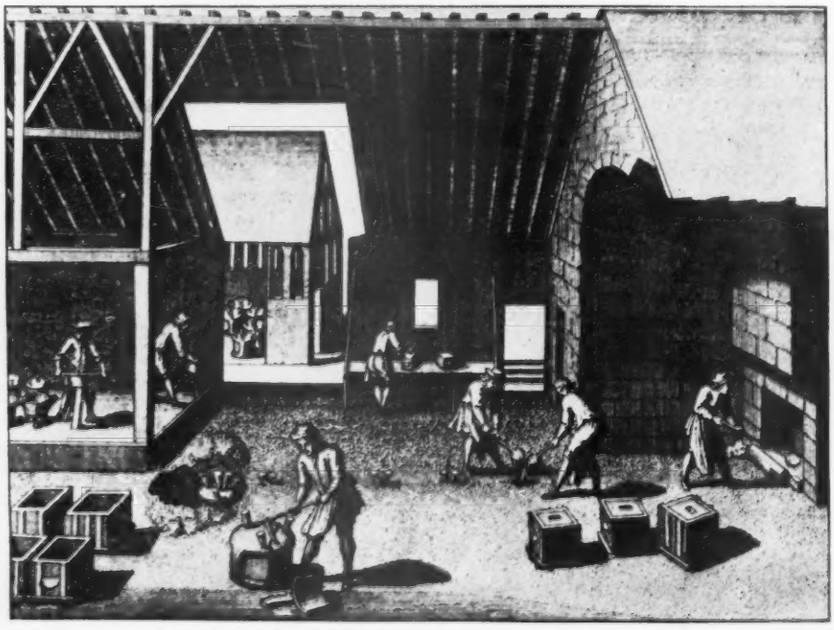


FIG. 14—INTERIOR VIEW OF FOUNDRY 1718

ter was entirely carbonized. The mold was then securely packed with soft earth and sand and poured through troughs from a furnace at a higher level. Fig. 10 shows the mold in position for pouring. The outline of the figure can be seen faintly by the dotted line. The men are shown constructing the clay-lined pouring troughs which lead the metal into the proper grates. A view of the furnace and melting room is shown in Fig. 12. The furnace is of the reverberatory type, the metal being tapped from the bottom and is allowed to run into the troughs below as shown in the previous illustration.

In the casting of his famous bronze Perseus, Cellini states that he was taken sick and the workmen let the bronze cake, but Cellini saved it by throwing oak wood on the fire. This melted out the tin, but Cellini again arose to the occasion by throwing in his pewter dishes. In describing the making of Cardinal's seals, Cellini mentions that occasionally a volcanic sand was used for molding.

Loam Method

The clay or loam method of casting was in use from time immemorial and was preferred for some purposes even after the invention of sand molds. It was particularly well adapted to the casting of peculiarly shaped kettles and bells.

Fig. 13 illustrates the clay and loam process as applied to the casting of kettles. The core for a kettle was made by wrapping hemp rope on a spindle to the approximate contour of the interior of the kettle. Clay was then applied to the rope core and the spindle revolved on the table until the rope was well covered and the outside took the shape of a templet made to conform to the shape of the core. The core was then well smeared with grease and covered with another layer of clay and revolved until the outside took the shape of a templet which was made to conform to the outside of the pot to be cast. In this manner a false kettle in clay was produced on the clay core. The whole was then again well greased, more clay applied and again revolved until the entire mass took the shape of another templet made to conform to the outside of the mold. In this manner three distinct layers of clay, each separated by a film of grease, were produced on the rope.. The entire mass was well baked, and with a knife the two outer layers were cut through the center line. The false clay casting was destroyed, the outer mold, now in two halves was replaced, leaving a space conforming to the shape of the casting desired. To prevent the core and outer mold from touching, lead balls whose diameter conformed to the thickness of the casting, were placed between the core and outer mold. Molds for legs and handles were made separately and were attached to the mold, as were also gate channels. After baking, the molds were embedded in the ground surrounded by soft sand.

In Fig. 13, *A* shows the man kneading and suddling the loam or clay with the feet, and also illustrates the wheelbarrow, heated water, etc.; *B* shows one man applying a layer of loam or clay with the templet and sizing the mold. The second workman is measuring the position for the handles. At *C*, the finished molds are shown baking over a long open furnace. The rope core is being withdrawn at *D*, and at *E*, the baked molds ready for pouring are shown. In Fig. 14 the pouring floor is illustrated.

The finished clay molds are embedded in the ground, only the gate holes protruding above. Two men are seen pouring, this particular casting requiring two gates which were poured at the same time.

One man is shown ladeling the metal from the furnace which appears to be of the pit type. The two men at the left, as well as the men in the foreground, are engaged in freeing the casting from the mold. For this purpose the mold is set upon a stool. Sand molding which had just come into practice is also shown in this view, one molder being at work in the background and a number of the flasks in evidence in the foreground.

Helmet for Arc Welders

A helmet for arc welders is illustrated and described in a 4-page folder issued by the Julius King Optical Co., New York City. This helmet affords protection to the eyes and faces of workmen from intense heat and light and yet permits the free use of both hands. It is constructed of black fibre which is a non-conductor of electricity and weighs only 23 ounces complete with the lenses. The cap furnished with the helmet is chemically-treated and fireproof, and is fitted with a self-adjusting spring head band.

David McLain, Goldsmith building, Milwaukee, is installing an open-hearth furnace in the plant of the George H. Smith Steel Casting Co., Milwaukee, which will have an output of from one to two tons per heat. The first heat in the furnace which Mr. McLain installed at the plant of the Lenoir Car Works, Lenoir City, Tenn., recently was made.

Testing Engineers Outline Comprehensive Program

A comprehensive program of papers and committee reports, requiring 10 sessions for presentation and discussion, has been outlined for the twentieth annual meeting of the American Society for Testing Materials to be held at the Hotel Traymore, Atlantic City, June 26 to 29. The opening session, Tuesday morning, will be devoted to the consideration of committee reports on "Wrought Iron", by S. V. Hunnings, chairman; "Revision of Pipe Threads", by H. V. Wille, chairman; "Magnification Scales for Micrographs", by W. H. Bassett, chairman, and "Standing Committees", and "Papers and Publications", by Edgar Marburg, chairman.

Papers and committee reports on tests and testing will be considered Tuesday afternoon. "Methods of Testing" will be the subject of a committee report, by G. Lanza, chairman. Among the papers to be read at this session are the following:

"Endurance and Impact Tests of Metals," by D. J. McAdams Jr.

"Rapid Semi-Autographic Tests for Determining the Proportional Limit," by H. F. Moore.

"The Use of the Scleroscope for Measuring the Elasticity of Non-Metallic Materials," by A. F. Shore.

On Tuesday evening, A. A. Stevenson, president will deliver his annual address and a reception will be tendered to the members and guests. Wednesday morning, June 27, will be devoted to the discussion of committee reports and papers on steel and iron, as follows:

Report of the Committee on Steel, by C. D. Young, chairman.

Report of the Committee on Cast Iron, by Richard Moldenke, chairman.

Report of the Committee on Corrosion of Iron and Steel, by S. S. Vorhees, chairman.

Report of the Committee on Magnetic Properties of Iron and Steel, by C. W. Burrows, chairman.

The following papers also will be presented:

"Some Applications of Magnetic Analysis to the Study of Steel Products," by C. W. Burrows.

"Annealing Temperatures and Grain Growth," by D. J. McAdams Jr.

The role of the several alloying elements in steel will be the subject of a topical discussion to be opened by H. M. Howe and other speakers will be announced later.

Non-ferrous metals will be considered Wednesday evening, the session to be opened by a report of the committee on non-ferrous metals and alloys, by William Campbell, chairman. The following papers will be read:

"Testing of Sheet Brass," by C. H. Davis.

"Specifications and Inspection for Brass and Bronze," by A. D. Flinn and Ernst Jonson.

"Interior Surface Defects on Brass Condenser Tubes as a Cause of Corrosion," by W. Reuben Webster.

"Effect of Light vs. Heavy Reduction in Cold-working Brass," by W. Reuben Webster.
"The Hardness of Hard Drawn Copper Wire," by Edwin H. Peirce.
"The Electrolytic Determination of Tin on Tinned Copper Wire," by G. G. Grower.

Thursday morning will be devoted to the consideration of preservative coatings and miscellaneous materials and the report of the committee on preservative coatings for structural materials will be presented by P. H. Walker, chairman. Thursday evening, cement and concrete will be considered; Friday morning, June 29, concrete and lime, and on Friday afternoon, ceramics. The tenth and closing session on Friday evening will be devoted to the consideration of the various committee reports on miscellaneous materials.

Officers for the ensuing year have been nominated as follows: For president, W. H. Bixby, brigadier-general, United States army, Washington, D. C.; for vice president, Edward Orton Jr., dean of the College of Engineering of Ohio State University and state geologist of Ohio, Columbus, O. For members of the executive committee: J. A. Capp, chief of the testing laboratory, General Electric Co., Schenectady, N. Y.; W. F. M. Goss, dean of the Schools of Engineering, University of Illinois, Urbana, Ill.; William M. Kinney, inspecting engineer, Universal Portland Cement Co., Chicago, and C. D. Young, engineer of tests, Pennsylvania railroad, Altoona, Pa.

On April 20 the membership of the society totaled 2,108 which represented a net increase of 37 since the last meeting and compares with a gain of 121 for the previous corresponding period.

A change in the regulations governing standing committees has been authorized by the executive committee, which provides that, as a general policy, only one individual connected with a given firm shall be eligible to membership on a committee, although exceptions to this rule may be permitted at the discretion of the committee concerned. However, if two or more members are connected with the same company, when a division is demanded, they shall jointly command only a single vote.

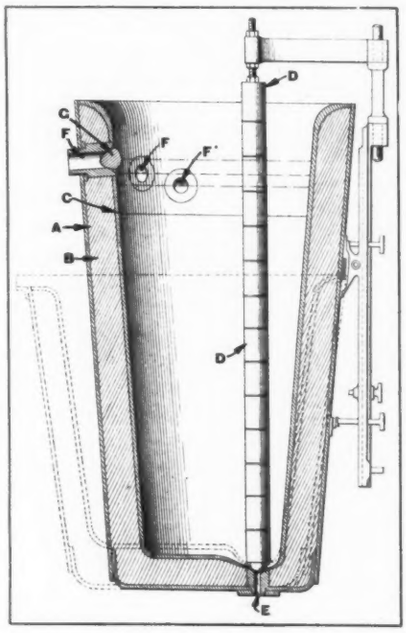
The Stow Mfg. Co., Binghamton, N. Y., has issued miniature reproductions of its catalogs devoted to electric tools and flexible shaft. These booklets are vest pocket size, 3¼ x 4¾ inches.

The Anson-Byrne Co., Chicago, sales agent for the Blaisdell air compressor, Kingsford centrifugal pump and other mechanical equipment, has removed into larger quarters at 10 South La Salle street.

A Self-Skimming Ladle for Pouring Steel for Castings

A new type of ladle for handling molten steel in foundries, the invention of James C. Davis, fourth vice president of the American Steel Foundries, Chicago, and the patent for which was assigned to this company, is shown in the accompanying illustration. This ladle is of smaller diameter and is much deeper than the type of ladle usually employed. It is pierced in the top with several circular openings which are staggered at different levels. The purpose of these openings is to provide outlets for the removal of slag.

The inventor states that the regenerative open-hearth furnace is the most universally employed medium for the production of basic steel. The proper adjustment of the metalloids of this furnace under skilled manipulation is comparatively simple, but when the contents of the furnace have been discharged into the ladle, the opportunity for further practical manipulation and treatment of the slag condition ceases. In its place a reaction commences between the slag and the steel. The tendency of this reaction is to nullify all of the work of purification that is carried out in the steel while in the furnace. In this reaction between the steel and the slag in the ladle, the time element is an important factor and the longer the two are in contact the greater is the opportunity for the reabsorption of metalloids.



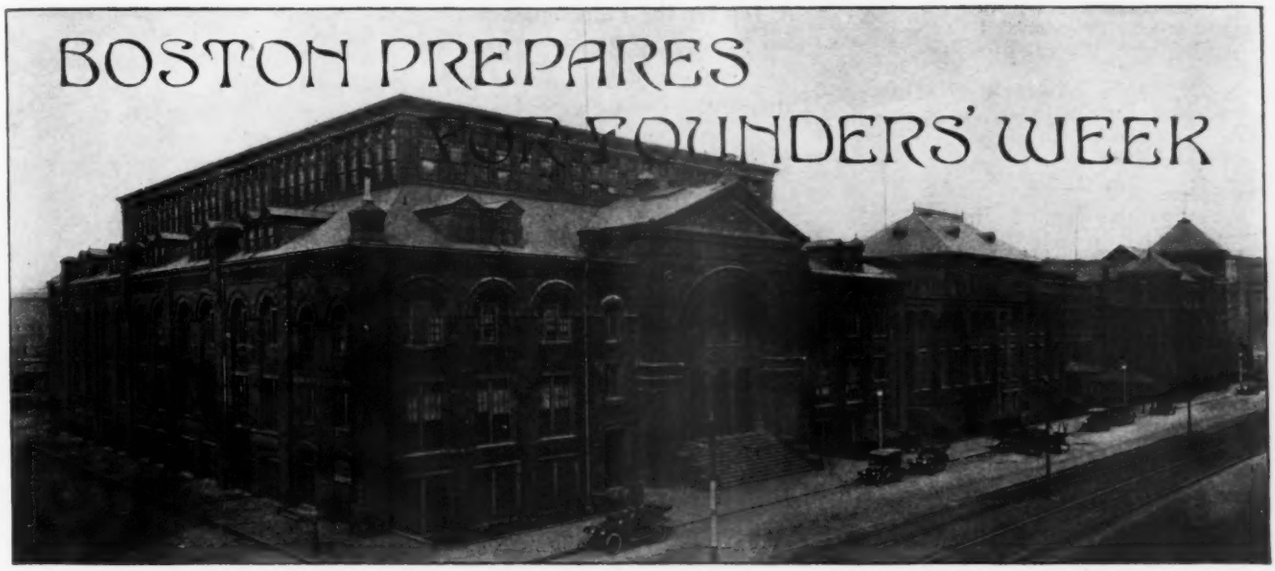
NEW TYPE OF LADLE FOR POURING CAST STEEL

During the time that the steel is in the ladle the combination of calcium with the silicon in the steel occurs, with a resulting interchange of phosphorus which re-enters the steel in the ladle. The effect of the loss of silicon from the steel to the slag is to liberate oxygen, thereby causing the steel to be porous when cast. Through the return of phosphorus from the slag to the steel, the latter is rendered brittle and is unfit for use, if in its ultimate form it is to be subjected to severe shocks or strain.

It is almost impossible to produce an exact quantity of steel of desirable chemical composition in the open-hearth furnace at one time, owing to the various delays which make necessary the addition of more metal than was contemplated in the original furnace charge. It is obviously necessary, therefore, that the ladle into which the steel and slag are to be discharged from the furnace must be of such ample proportions as to properly receive and contain not only the original charge, but such additional amounts of metal which may be found necessary to produce. Therefore, when a heat of steel of normal proportions shall have been discharged into the ladle there is so much space between the top of the steel and the top of the ladle that the ladle receives an excessive amount of slag. This slag remains on the metal until it has been completely discharged from the ladle. It is evident, therefore, that the greater the volume of slag contained in the ladle the greater is the hydrostatic head or pressure exerted by the slag, thereby causing the latter to settle more deeply into the steel and increasing the contaminating effect of the slag.

The new type of ladle makes it possible to expose 45 per cent less area of steel to the detrimental action of the slag than the old style ladle, and has the further advantage of imparting a greater hydrostatic head to the metal which the inventor claims to have the effect of causing the lighter slag to rise to the top of the steel and remain there while the ladle is being emptied.

Before the ladle is filled with steel, the slag openings are closed with a plug composed mainly of silica sand, with a binder of fire clay, and these plugs can be removed as required in order to regulate the height of the slag in the ladle to a proportion just sufficient to serve as a blanket to prevent chilling the steel. As shown in the accompanying illustration, the ladle consists of an exterior shell, *A*, a brick lining, *B*, and a thinner lining, *C*, of material containing magnesite and dolomite. The stopper is shown at *D*, the pouring opening at *E*, and the slag holes at *F*. How the slag holes are plugged is illustrated at *G*.



Conventions and Exhibitions in New England

NEW ENGLAND foundrymen already are making extensive preparations for the reception and entertainment of the members of the American Foundrymen's Association and the American Institute of Metals, who will meet in annual convention in Boston, during the week of Sept. 24. Concurrent with this great gathering of foundrymen will be held the yearly exhibition of foundry equipment and supplies, machine tools and accessories, in Mechanic's building, which affords 80,000 square feet of floor space.

Never before in the history of these organizations has as much interest been manifested in this event, as far in advance of the opening date, as this year. Space reservations for exhibits already have been made by 83 manufacturers and last year's total of 150 at Cleveland, promises to be greatly exceeded. The average space per exhibitor also shows a big increase over previous years and the indications are that Mechanic's building will be crowded to capacity. A prominent feature of the Boston show will be the extensive display of machine tools. New England builders promise to be unusually well represented and numerous reservations also have been made by machine tool builders in the central west.

Great Patriotic Demonstration

The Boston exhibition will be a great patriotic demonstration of the preparedness of equipment builders to meet the most exacting needs of foundrymen and machine shop operators in this great crisis. The labor-saving tools that will be displayed will demonstrate how operations can be speeded-up to meet the demands of the government and, in addition, engineers will be in attendance who will explain the intricacies of munitions manufacture.

The program for the technical sessions of the American Foundrymen's Association is unusually complete and provides for separate sessions for the discussion of gray iron, steel and malleable iron topics. Three symposiums have been scheduled, namely "Military Stores", "After-Treatment of Castings to Improve Their Physical Characteristics" and "Refractories". The opening meeting on Monday afternoon, Sept. 24, will be a joint session of the American Foundrymen's Association and the American Institute of Metals. Throughout the remainder of the week, ending with Friday, Sept. 28, only morning sessions will be held and the same plan will be followed, which proved so satisfactory at Cleveland last year. It is probable that simultaneous sessions of the malleable and gray iron and steel sections will be held Wednesday, Thursday and Friday. The exhibition will be formally opened Tuesday morning, Sept. 25, and will close Friday evening.

Headquarters for the American Foundrymen's Association will be at the Copley-Plaza hotel, although the meetings will be held in the Mechanic's building. The American Institute of Metals will have its headquarters at the Hotel Somerset and its meetings either will be held at this hotel or in the exhibition building.

The foundrymen of New England have completed a strong organization to provide for the reception and entertainment of the visitors. While their plans have been outlined only tentatively, the program includes a boat trip around Boston harbor, theater party, a visit to one of the big league parks to witness a professional ball game, ladies' luncheon and plant visitation. The complete list of committees appointed by the New England foundrymen, follows:

Executive Committee

W. J. Lavelle, chairman, New England Coal & Coke Co., Everett, Mass.
J. O. Henshaw, 79 Milk street, Boston.
C. A. Reed, Reed, Fears & Miller, Boston.
R. D. Walker, Walker & Pratt Mfg. Co., Boston.
W. E. Freeland, *The Iron Age*, Worcester.
A. R. Plant, Blackstone National Bank, Providence, R. I.
W. A. Viall, Brown & Sharpe Mfg. Co., Providence, R. I.
Fred F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass.
A. B. Root Jr., Hunt-Spiller Mfg. Corp., Boston.
T. R. Scott, Brown & Sharpe Mfg. Co., Providence, R. I.

Reception Committee

E. A. Tutein, chairman, Thomas Iron Co., 53 State street, Boston.
H. Paul Buckingham, Arcade Malleable Iron Co., Worcester.
H. F. Winlock, Barbour-Stockwell Co., Cambridge, Mass.
George H. Gibby, Gibby Foundry Co., Boston.
W. Scott Thomas, J. W. Paxson Co., Providence, R. I.
F. B. Farnsworth, McLagon Foundry Co., New Haven, Conn.
George A. Ray, Taylor & Fenn Co., Hartford, Conn.
H. W. Woodworth, American Tool & Machine Co., Boston.
Charles Van Stone, Lumsden & Van Stone Co., Boston.
D. D. Bartlett, Builders Iron Foundry, Providence, R. I.
F. W. Stickle, Capitol Foundry Co., Hartford, Conn.
Robt. C. Newcomb, Deane Steam Pump Works, Holyoke, Mass.

Finance Committee

W. A. Viall, chairman, Brown & Sharpe Mfg. Co., Providence, R. I.

H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
W. J. Breen, Wm. J. Breen Co., Boston.
A. N. Abbe, American Hardware Corp., New Britain, Conn.
A. R. Plant, Blackstone National Bank, Providence, R. I.
A. J. Miller, Whitehead Bros. Co., Providence, R. I.
W. C. Fish, General Electric Co., Lynn, Mass.
L. G. Kibbe, Turner & Seymour Mfg. Co., Torrington, Conn.

Ladies' Entertainment Committee

R. D. Walker, chairman, Walker & Pratt Mfg. Co., Boston.
L. S. Brown, Springfield Facing Co., Springfield, Mass.
Charles L. Newcomb, Deane Steam Pump Works, Holyoke, Mass.
Robt. C. Bird, Broadway Iron Foundry, Cambridge, Mass.
Carl S. Dixon, General Electric Co., Pittsfield, Mass.
W. H. Coffin, Springfield Facing Co., Springfield, Mass.
J. F. Lanigan, Davis Foundry Co., Lawrence, Mass.
W. M. Saunders, Saunders & Franklin, Providence, R. I.

Entertainment Committee

C. A. Reed, chairman, Reed, Fears & Miller, Boston.
W. T. Bennett, secretary, Griffin Wheel Co., Chelsea, Mass.
S. E. French, Athol Machine Works, Athol, Mass.
T. Officer, Sullivan Machinery Co., Claremont, N. H.
A. F. Corbin, Union Mfg. Co., New Britain, Conn.
H. A. Nealley, Jos. Dixon Crucible Co., Boston.
G. P. Aborn, Blake & Knowles Steam Pump Works, Cambridge, Mass.
C. A. Olson, Walworth Mfg. Co., Boston.
B. S. Leslie, United Shoe Machinery Co., Beverly, Mass.
T. R. Scott, Brown & Sharpe Mfg. Co., Providence, R. I.
Chas. V. S. Paul, R. Estabrook's Sons, Boston.
Charles L. Nutter, Old Colony Foundry, Bridgewater, Mass.
C. E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
E. B. Freeman, B. F. Sturtevant Co., Hyde Park, Mass.
D. F. Eagan, Hotel Seymour, Lynn, Mass.
D. F. Curtin, Waltham Foundry Co., Waltham, Mass.
A. L. Haasis, Jos. Dixon Crucible Co., Jersey City, N. J.

Golf Committee

J. O. Henshaw, chairman, 79 Milk street, Boston.
A. E. Blazo, Rogers, Brown & Co., Boston.
C. A. Wyatt, Debevoise-Anderson Co., Boston.
Thomas F. Stokes, Alley & Page Co., Boston.

Press Committee

W. E. Freeland, chairman, *The Iron Age*, Worcester, Mass.
A. W. Howland, *The Foundry*, 90 West St. building, New York.
A. O. Backert, Cleveland.

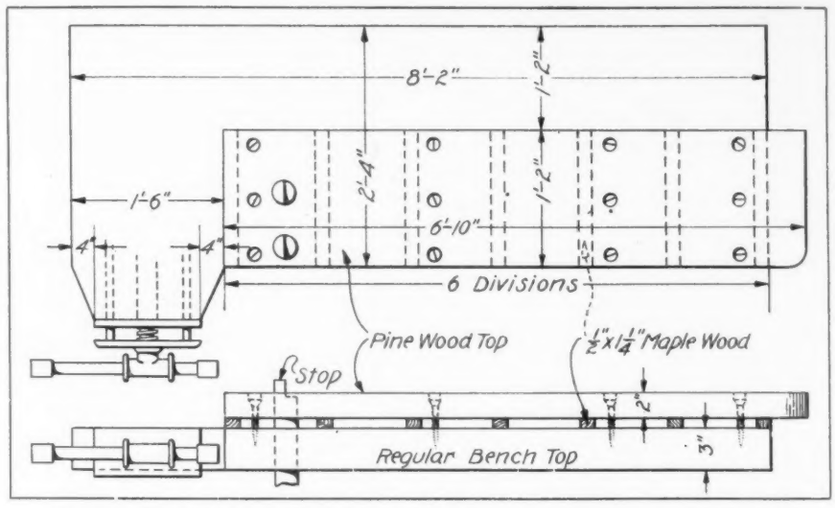
A Top for the Patternmaker's Work Bench

By M. E. Duggan

Patternmakers usually find that it is almost impossible to do good work on a bench whose top surface is warped and twisted. Most employes of the pattern shop do not take kindly to frequent dressing of the bench top, but it is generally agreed that a smooth polished surface tends toward better work and encourages the patternmaker to exert more care and accuracy in making patterns.

The standard practice in most pattern shops is to fasten a pine board on the regular bench top. As this board is fastened directly to the top of the bench, there is no chance for air to circulate against the lower surface of the board. This lack of circulation causes the exposed top surface to dry and contract, producing a concave surface.

The warping of the bench top can be avoided by attaching the pine board to the bench in the manner shown in the accompanying illustration. The cleats provide for an air space of 2 inches, which insures equal exposure of the wood on all surfaces and thus prevents uneven contraction.



METHOD OF FASTENING BENCH TOP SO THAT IT WILL NOT WARP

Open-Flame Furnace for Melting Statuary Bronze

Oil-fired open-flame melting furnaces have been used successfully for melting art bronze at the plant of the Gorham Mfg. Co., Providence, R. I. Two of these furnaces recently were installed in this foundry by the Monarch Engineering & Mfg. Co., Baltimore. Several additional furnaces of this type will be added to the present furnace equipment. One of the notable pieces of statuary recently cast by the Gorham company with bronze melted in this open-flame furnace was that of Phillips Brooks, a prominent Episcopal bishop of New England; 4,850 pounds of metal were required for casting this statue. The metal was melted in two open-flame furnaces which were charged at 12:10 p. m. and the metal was poured at 3:45 p. m.; 7½ minutes elapsed from the time the first metal entered the mold until it was filled.

Cores for Steel Castings

Question:—Can you give us some information regarding the best sand and binder to use for heavy steel castings? We are using silica sand with flour and oil binder, which is giving good results on medium weight castings but does not seem to work well on heavier sections.

Answer:—Flour is not a desirable addition to a sand facing for metals with a high melting point such as steel, nickel, etc., because it generates considerable gas. Carbonate or sulphate of lime, is often present, and these, at a steel melting temperature, exert a fluxing action on the sand, causing it to fuse onto the casting, leaving pit holes because in fusing it swells into small bubbles. Use silica sand containing over 97 per cent silica and bond with high grade fire clay and molasses water. Mill the sand thoroughly. Mix the sand and clay in such proportions as will produce a molding mixture that will pack when squeezed in the hand, like good molding sand. For dry sand work it may be necessary to add a little flour to bond the sand when dried. Paint the molds with silica wash for dry sand work.

The Lewis Machine Co., Cleveland, formerly located at 830 Long avenue, has removed its plant to 6303 Central avenue.

Early Stove Manufacture in the United States

The Oldest and Best Preserved Cook Stove in America is Described and Illustrated and the Method of Molding is Discussed

By W J Keep

FIG. 1—COOK STOVE MADE AT HEREFORD FURNACE, PA., IN 1767 AND CAREFULLY PRESERVED BY THE MICHIGAN STOVE CO.

QUESTION:—When were the first cast iron stoves made in the United States, and what was the composition of the iron used?

Answer:—The first blast furnace in America was erected at Lynn, Mass., in 1644, and smelted bog ores with charcoal. At the Essex museum, Salem, Mass., is a cast iron fireback made at this furnace, which contains the inscription cast thereon, entitled, "Pickering 1660". This fireback was found in the Pickering house in Salem and probably is the oldest American casting connected with the burning of fuel for domestic purposes which thus far has been found.

The first charcoal blast furnaces in Pennsylvania were erected between the years 1720 and 1750. In 1742, Dr. Franklin's open front stove was made at the Warwick furnace. During these years the Pennsylvania Germans brought to this country "five-plate stoves", otherwise termed "jamb stoves". The five castings consisted of a bottom, top, two sides and the back, which were ornamented with Biblical pictures. These castings were held together by one rod through lugs in the top and bottom. The open end was built into the back of the fireplace of an adjoining room and extended about 2 feet into the room behind the fireplace. It had no legs and the bottom was about 15 inches from the floor. The stove obtained its heat by radiation from the fire, and to increase the heat, burning coals could be shoveled into it.

Sometimes a jamb stove was erected in an outer wall, the open end being outdoors. A fire could be built in it, but it had no pipe or chimney. By adding an end to the five-plate stove which contained a door for the introduction of wood, and by attaching a smoke pipe and setting the stove on a stand, it was converted into a "six-plate" or box stove. Prior to 1750, these stoves were carved and contained illustrations of Biblical subjects.

These stove were made for a period of about 10 years, when in 1665 the English brought to Pennsylvania the same kind of stoves ornamented with scroll work. However, the English added four plates to form a small oven and these were called "ten-plate" stoves.

The foregoing information was gathered from *The Bible in Iron*, written by Henry C. Mercer.

In 1892, the Michigan Stove Co., Detroit, offered $100 for the oldest and best preserved cook stove made in America. This produced much information regarding early stoves which otherwise would have been lost, and the Michigan Stove Co. obtained one of these 10-plate stoves made at Hereford Furnace, Pa., in 1767. This stove was made by the proprietor of this furnace, Thomas Mayburry, and it was exhibited by the Michigan Stove Co. at the World's Fair in Chicago in 1893. In its present preserved form, this early cook stove is illustrated in Fig. 1, and Fig. 2 shows the details of its construction. This stove, cast only two years after

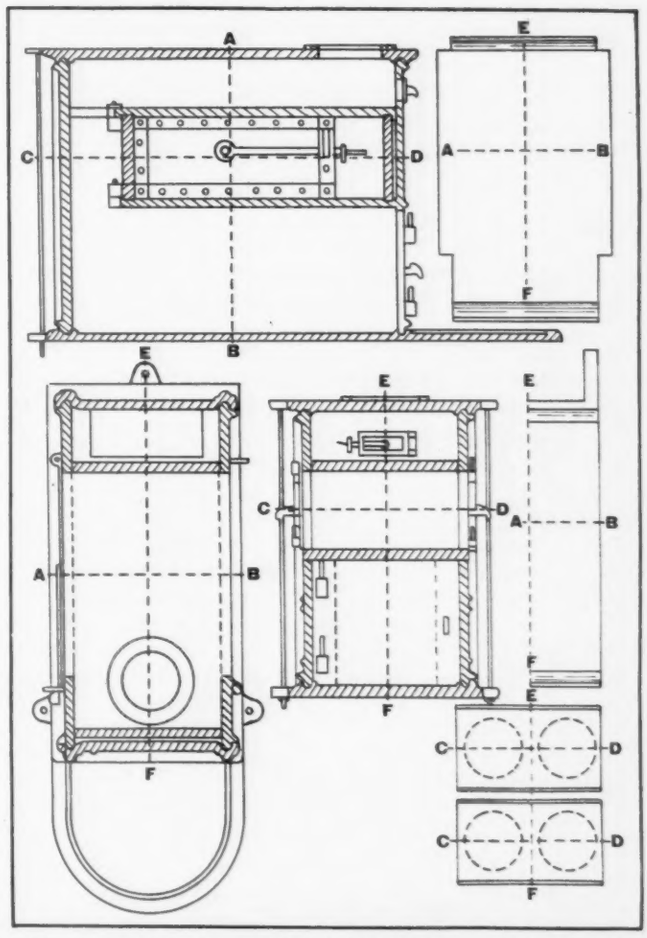


FIG. 2—DETAILS OF CONSTRUCTION OF THE COOK STOVE ILLUSTRATED IN FIG. 1

the introduction of this type, was made in open sand on the floor of the furnace cast house from iron as it was tapped out of the stack. The mold was made by pounding a board into the sand, on one side of which the design was carved. The iron was poured into and flowed over the mold, and the casting was from ½ to ¾-inch thick. This stove was known as the *small* size and weighs 372 pounds. Two other sizes also were made, known, respectively, as *medium* and *large*. The plates were held together by three rods on the outside. The doors were made from wrought iron by a blacksmith, which he reduced to a thickness of about ⅛-inch by hammering and this same thickness of metal was used for the pipe. Rolled sheet iron was not available until many years later. Only one of the large doors remains and this is rusted through just above the lower band.

The first American cook stove which was worthy of the name was patented by W. T. James on April 26, 1815, and was made and sold by him at Troy, N. Y. An etching of this stove is shown in Fig. 3.

The catings were poured in flasks at a blast furnace near Philadelphia and were shipped to Troy, N. Y., where they were assembled. It was supposed that the only iron suitable for stoves was the metal tapped from the blast furnace.

In the early days, stoves were peddled from wagons and produce was taken in payment as there was very little money in circulation at that time. Complete stoves were shipped by water to Philadelphia to pay for the castings made in that city.

The foregoing information is from the manuscript of the "History of Stoves," by the author, and in a later issue of *The Foundry* the first American base burning stove will be illustrated and described.

Brick Made From Ashes

The Wagner Fire Brick Co., Scranton, Pa., is completing a plant near that city which will have a capacity for producing 50,000 fire brick daily, and will be placed in operation about the middle of June. The product will be of an unusual character, comprising fire brick and fireproof building brick made from coal ashes by a patented process developed by Earl V. Wagner, formerly chemist for the Lackawanna and Erie railroads and for the Scranton Electric Co. Several thousand brick already have been made and were subjected to thorough tests by the Spencer Heater Co. and National Paving Co., Scranton, and the Allegheny Window Glass Co., Port Allegheny, Pa. The results of these tests are claimed to prove the coal ash brick superior in heat-resisting qualities to clay brick. The Wagner brick have a fusion point of from 2,600 to 3,250 degrees Fahr., depending upon the binder; a crushing strength of 1,300 pounds or more per square inch and the porosity is 22.5 per cent. The binder employed is a combination of magnesia, alumina, sodium, silicate and crude fibrous asbestos. The company's plant is designed along modern lines and is being equipped by the American Clay Machinery Co., Bucyrus, O., with a full line of automatic and sem-automatic brick machinery.

Magnesite Bottoms for Electric Furnaces

A new method of making magnesite bottoms for electric furnaces, is the subject of a patent granted to James H. Gray, of the United States Steel

FIG. 3—COOK STOVE PATENTED BY W. T. JAMES IN 1815 AND MANUFACTURED AT TROY, N. Y.

Corporation, New York. The process, as described by the inventor, follows:

"I first place a layer of magnesia bricks on the bottom of the shell of the furnace and then place a layer of granular magnesia one or two inches thick on the bricks. I then heat the furnace and the magnesia to such a temperature that the latter becomes a good conductor of electricity. This may be done in any one of several ways. For example, a flame furnished by fuel oil may be introduced into the furnace, or a bed of coke may be laid on the magnesia and the electric current passed through the coke from the electrodes in the manner described to heat the same to incandescence, or lengths of electrodes may be laid on the bottom and the regular electrodes lowered to strike arcs therewith and to pass an incandescing current through these special lengths. Any one of these methods will bring the main electrodes to a white heat and will furnish sufficient heat in the furnace to bring the magnesia to a temperature at which it becomes a sufficiently good conductor of electricity. When this temperature is reached the electrodes are lowered to the bottom of the furnace (removing any coke or similar material which may have been introduced for the initial heating) and arcs are struck between the electrodes and the now conductive magnesia. The arcs and the current passing through the magnesia increase its temperature until it becomes molten or semi-molten or pasty. When this condition has been obtained more magnesia in granular form is introduced about the electrodes and this in turn becomes conductive as it receives heat both from the electric arcs and from the heated walls and atmosphere of the furnace. As the material banked about the electrodes becomes conductive, the electrodes are gradually raised so as to maintain the necessary resistance at the arcs for the desired number of amperes of current to flow through the electrodes, the raising of the electrodes being accomplished either by hand or by automatic regulators such as are now generally employed for regulating the height of electrodes in such furnaces. The hearth is thus built-up to the desired depth and shape in a sound and reliable monolith, by throwing in new material progressively at such points as may need building up."

Semi-Steel Castings

By W. J. Keep

Question:—In making semi-steel castings, is it preferable to use horseshoes or boiler punchings and shearings? I understand the former are made by the basic process. I would like to know what takes place metallurgically in the basic and acid processes of making steel.

Answer:—The process by which the steel is made will have no influence on your semi-steel. If the fluid metal does not lie still in the mold or is not fluid enough, or contains blow-holes, place about 0.1 per cent pure aluminum in the ladle before you pour iron into it.

The terms "basic" and "acid" apply to the lining used in the furnace. The shape of the furnace is also different and the pig iron used also varies in some respects, but chemically the final product is not expected to differ materially. Basic pig is a low-silicon and low-sulphur iron, the standard being 1.00 per cent silicon and sulphur under 0.05 per cent. Acid or bessemer pig contains phosphorus under 0.1 per cent; 1.00 to 1.25 per cent silicon and sulphur under 0.05 per cent.

The Care to be Exercised in Vibrator Operation

This Valveless Engine is an Important Piece of Equipment Which Should Receive More Than the Ordinary Care From the Foundryman

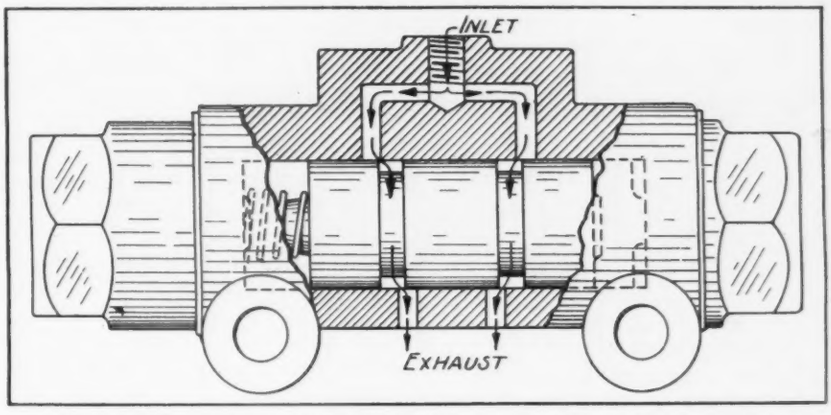
By Harry H Barclay

IN THE gradual transition from hand to machine molding, foundry vibrators are among the least understood and most abused of the many accessories now in general use in modern casting plants. How many molders know that a vibrator is practically a valveless engine, so delicately adjusted and perfectly fitted, that a few grains of sand or a particle of the inner lining of the air hose will clog the inlet ports and put it out of business? Some of our best mechanics expect a machine of this nature to run indefinitely without care, cleaning or oil—and to be practically indestructible. Some of the experts in the electrical profession have been asked to tell us how many blows a vibrator hits per minute, or to rig up an electrical contrivance to count the blows, but they have never been able to get accurate results. A well-known molding machine builder pasted a long strip of white paper on the bed of a planer and fastened a marker with a coiled spring on one head of a ¾-inch vibrator, which was held rigidly as close to the paper as possible, while the bed of the planer moved along; the dots made on the paper in a given length of time were counted and the vibrator hit nearly 14,000 blows a minute. To get this rapidity of motion, which means that the vibrator plunger has to come to a dead stop and then start up again 28,000 times a minute, the vibrator must be designed so it can hang on a dead center and blow through on both ends; that is, by placing the plunger centrally, as shown in the accompanying illustration, the air can come through both inlet ports at the same time, pass through the air ports in each end of the plunger and out of the exhaust ports, while the plunger remains stationery.

This valveless engine, which is what a vibrator really is, does not even have a flywheel to carry it over the center, but depends on the momentum acquired before the dead center is reached to complete the stroke. To acquire this speed, the air must be admitted quickly and should be of sufficient volume to fill the air chamber instantly; the plunger will then carry over the dead center with sufficient velocity to hit a good blow regardless of the air cushion already waiting to carry the plunger on the return stroke. All vibrators will run better without a spring. Its function is solely to put the plunger in the correct starting position. After the plunger gets a start, the spring is a detriment. An experience of over 12 years devoted entirely to vibrators under almost every conceivable condition of operation leads to the conclusion that at least 75 per cent of all vibrator troubles are caused by placing the starting valve too far away from the vibrator and using a valve that admits the air slowly instead of with a snap. To fill a hose line full of air, even though the line be only a few feet long, lets the weak pressure in front get the vibrator on the center before enough resistance is formed to equalize the pressure.

The ideal wearing surface is a hardened tool steel plunger running in a cast iron or semi-steel body, the bearing surface of which soon gets glazed and smooth, while a hardened plunger running in a hardened and ground steel body frequently freezes to the body unless oiled at least once every day. The rust caused by the moisture in compressed air will adhere to both the body and plunger which will rust the two so tightly together that it is frequently necessary to take both heads off the vibrator and drive the plunger out with a drift and then lap the plunger in again. Rust has no affinity for the glazed surface of hard semi-steel and will not adhere to it. A vibrator of this material, which ran continuously for 260 hours without a drop of lubrication, was found to be in perfect condition when the test was completed.

A drop-forged chrome-vanadium steel body of the same shape and size had to be oiled every five hours, as it was constantly running hot, but was torn apart by the vibrations between the 64th and 65th hour of the test. A satisfactory vibrator for plate work should be strong enough to last at least two years, operating 10 hours per day, yet light enough not to be a burden to the molder. It must start instantly and do snappy work, and the least we can do to help it along is to give it care and a fair chance.



VIBRATOR CONSTRUCTION SHOWING INLET AND EXHAUST PORTS

A New Core Buster

George Oldham & Son, Philadelphia, are manufacturing a pneumatic tool known as a core buster, which is designed for cutting out cores quickly and economically. By the use of this tool heavy cores in large castings can be removed in much less time than is required when the work is done by hand, and it is claimed that one man with this tool can do the work of three or four not so equipped. The chisel is held in a retainer by a spring lock washer and the air-cushioned chisel bushing is held in place by a supply of live air only when the chisel is in operation. By this pneumatic feature the shock is absorbed.

The City Pattern Works, Detroit, manufacturer of wood and metal patterns has been compelled to increase its facilities and has moved into larger quarters at 144 to 156 Congress street.

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Are Conventions Worth While in War Time?

PROMPTED by the belief that the calling together of the members of a national organization of engineers, business men, or tradesmen has a distressing effect upon the work of preparing the nation for war, a number of well known railway associations have postponed their annual conventions. This action has raised the question, "Are conventions worth while in war time?"

In the light of events that have transpired during the past few weeks, the question may be answered in the affirmative. Beginning May 2, members of the American Electrochemical Society convened at Detroit in one of the most successful meetings of the organization. The American Society of Mechanical Engineers and the National Machine Tool Builders' Association held meetings at Cincinnati during the week of May 21. It can safely be said that these meetings were the source of more valuable information regarding the manufacture of munitions than had previously been imparted to American engineers and manufacturers. On May 25 and 26 at New York the American Iron and Steel Institute devoted much time and attention to the problems of steel manufacturers in meeting the exigencies of war.

The success attending the meetings mentioned in the foregoing paragraph is sufficient proof that conventions are worth while, yet it is possible to go further and to show that such meetings are a positive necessity. England and France have found that the development of the iron and steel and kindred industries has been hastened by the war. It is fast dawning upon the authorities that the dissemination of information which assists in prosecuting the war more vigorously is best effected through the medium of the engineering and technical organizations. This explains why in war-fatigued England, such societies as the British Foundrymen's Association, the Institute of Metals, and the Iron and Steel Institute, and the various engineering organizations, are more active now than before the war.

The entrance of the United States into the war has added to the burden of manufacturers. There is more need now that ever before for a thorough discussion of business conditions, engineering topics and operating problems. For this reason, the 1917 conventions of the American Foundrymen's Association and the Institute of Metals have a more definite and valuable function to perform than ever before. The September meetings will render a distinct service to the country in placing before the foundrymen the very information they must have in order to properly perform their part in the national program of successfully waging war.

Prices of iron and fuel are still seeking higher levels. No. 2 foundry pig iron is quoted in the leading trade centers as follows: Pittsburgh, $43.95; Chicago, $43; Cleveland, $43 to $45; Buffalo, $43 to $45; Birmingham, $36 to $40; and Philadelphia, $42.50 to $43. Basic iron is held at $42.95, and bessemer at $45.95 to $48.95, Pittsburgh. Lake Superior charcoal iron is quoted at $49.25 to $51.75, Chicago. Prompt coke is firm at $9.50 to $10, and for second half delivery, $8.50 to $9.50, at the ovens.

Personal

Augustus S. Blagden, formerly vice president of the American Malleables Co., Buffalo, has been elected president.

George H. Rolinson has been appointed superintendent of the foundry operated by The Connersville Blower Co., Connersville, Ind.

E. C. Bauer who has been connected with the sales department of the American Manganese Steel Co., Chicago, has been appointed assistant to the vice president.

Joseph C. Sanders, formerly vice president of the American Foundry & Mfg. Co., St. Louis, has been elected president to succeed the late Barney H. Sanders.

W. J. Scholes has been appointed superintendent of the foundry branch of the General Motors Co., located at Stockton, Cal., where gas tractors are manufactured.

Ralph Donaldson, Pittsburgh, has been appointed superintendent of the Bucyrus, O., plant of the Ohio Steel Foundry Co., Lima, O., succeeding C. W. Lytle, resigned.

G. S. Evans has resigned as superintendent of the foundry of the Lenoir Car Works, Lenoir City, Tenn., and has been succeeded by H. N. Curd.

C. G. Howe has been appointed New England sales representative of the E. J. Woodison Co., Detroit, manufacturer of foundry supplies and equipment. Mr. Howe will travel out of Boston.

W. C. Hammond, assistant manager of the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa., for a period of nine years, has been appointed manager of the Wm. E. Hill Co., Kalamazoo, Mich.

At the annual meeting of the Newark Foundrymen's Association, officers were elected as follows: Arthur E. Barlow, president; George Krouse, vice president; John Campbell, treasurer, and Ulrich Eberhardt, secretary.

George Mitchell, of the Pittston Stove Co., Pittston, Pa., was re-elected president of the Stove Founders National Defense Association at the annual meeting of this organization, held in Chicago on May 8.

Fred Sill, of the Sill Stove Works, Rochester, N. Y., was elected president of the National Association of Stove Manufacturers at its forty-sixth annual meeting held at the Congress hotel, Chicago, May 9 and 10.

George W. Knotts, Pittsburgh, has been appointed manager of the William Tod, Lloyd-Booth and Oak Street shops, Youngstown, subsidiary plants of the United Engineering company.

Charles H. Booth has resigned as chairman and member of the executive committee of the United Engineering & Foundry Co., Pittsburgh, because of ill health. However, he will continue as a member of the board of directors.

John D. Hurley, vice president of the Independent Pneumatic Tool Co., Chicago, has been elected president to succeed the late James Buchanan Brady. Ralph S. Cooper, manager of the New York office of this company, was elected vice president to succeed Mr. Hurley and Robt. T. Scott, manager of the Pittsburgh branch was elected a director and member of the executive board.

Book Review

Annual Chemical Directory of the United States, edited by B. F. Lovelace; cloth; 305 pages, 6 x 9 inches; published by Williams & Wilkins Co. and furnished by *The Foundry* for $5 net.

In the past two years the United States has been thrown on its own resources as far as chemical products are concerned. The progressive spirit which is pregnant throughout the chemical industry is evidenced in the publication of "The Annual Chemical Directory of the United States". This is the first edition of the book, and a review of its contents will give an idea of its value. Section I contains a list of the chemical products manufactured in the United States with the names of the manufacturers. Names of American manufacturers and dealers in apparatus and equipment, machinery and mechanical supplies useful or essential for scientific and technical laboratories, industrial plants and organizations are given next. Other sections list professional chemical firms; federal, state, municipal, industrial and professional laboratories, American and foreign colleges, offering courses in chemistry; experiment stations in the United States and the principal foreign countries; federal and state officials of dairying, foods, drugs, etc.; American and foreign technical and scientific societies; also American and foreign chemical journals and important chemical books published in 1916-17. Chapter X summarizes the new and important happenings in the field of chemistry in 1916, while Chapter XI tells of new devices, methods and appliances for handling industrial chemical problems.

Charles Vickers, Metallurgical Editor of The Foundry

The editorial staff of *The Foundry* has been further strengthened by the appointment of Charles Vickers, Niagara Falls, N. Y., as metallurgical editor. For a number of years, Mr. Vickers, who has had a wide experience as a brass foundryman, was associate editor of *The Foundry,* and five years ago he resigned to accept a position with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Throughout this period, however, he was a regular contributor to *The Foundry,* and conducted the department devoted to "The Problems of the Brass Founder". In addition to his editorial duties, Mr. Vickers will engage in consulting work in the brass foundry field. His wide experience as a practical brass foundryman, chemist and metallurgist, enables Mr. Vickers to bring to his work a wide knowledge of the uses of non-ferrous metals and their manufacture and conversion into finished articles of commerce.

What the Foundries Are Doing

Holt Brothers, Concord, N. H., are building a foundry, 60 x 175 feet.

Robert D. Alger, West Bridgewater, Mass., will erect a grey iron foundry, 50 x 70 feet.

The Elmira Foundry Co., Elmira, N. Y., will erect a foundry, 90 x 300 feet.

The Reading Knob Works, Reading, Pa., is having plans prepared for an addition to its foundry, 50 feet square.

The Illinois Malleable Iron Co., Chicago, contemplates the erection of an addition to its foundry, 154 x 325 feet.

The St. Maurice Foundry Co., Three Rivers, Que., Can., is erecting a foundry at a cost of approximately $30,000.

The Northwestern Brass & Aluminum Co., Rochester, N. Y., is having plans prepared for the erection of a brass foundry.

The Plymouth Motor Castings Co., Plymouth, Mich., shortly will begin the erection of an extension to its foundry, 50 x 420 feet.

The Duriron Castings Co., Dayton, O., will erect an addition to its plant at an estimated cost of $7,000.

The Favorite Stove & Range Co., Piqua, O., is extending the capacity of its plant by the erection of a new building.

The Weatherly Foundry & Machine Co., Weatherly, Pa., is erecting an extensive addition to its plant.

The Aluminum Castings Co., Cleveland, is erecting an addition to its Buffalo plant, 130 x 260 feet.

The Sheffield Car Co., Three Rivers, Mich., will erect an addition to its foundry, 128 x 378 feet.

The Roberts Brass Co., Milwaukee, manufacturer of automobile specialties will build a new plant, 40 x 100 feet.

The Huntington Steel Foundry Co., Huntington, Ind., will erect a 2-story addition to its plant to be used as a pattern shop.

Wettlaufer Brothers, Toronto, Can., will build a foundry and machine shop at Frederickton, N. B.

The Taylor Coupler & Steel Castings Co., of which J. C. Taylor, 542 Ohio Bldg., Toledo, O., is president, will erect a foundry at Ironville, O.

Walter B. Taylor, Worcester, Mass., manufacturer of brass castings has awarded a contract for the erection of a new foundry, 50 x 80 feet.

The capacity of the Lansdale Foundry Co., Lansdale, Pa., is being increased considerably by the erection of an additional core shop, shipping room, machine shop, etc.

The American Radiator Co., Buffalo, will erect an addition, 100 x 200 feet, to its Pierce plant at Elmwood and Hertel avenues and the New York Central Railroad belt line.

The Wadsworth Foundry Co., Wadsworth, Ohio, is erecting a gray iron jobbing foundry, 60 x 80 feet. The company is capitalized at $15,000 and C. C. Paterson is president and general manager.

The Hammond Malleable Iron Co., Hammond, Ind., will erect an addition to its plant, 70 x 280 feet. A 25-ton furnace will be installed. A shipping room, 100 x 160 feet, and a new office building also are under construction.

The General Electric Co., Schenectady, N. Y., will erect another foundry, 125 x 525 feet, one and two stories high, with wings 36 x 250 feet. The approximate cost of this plant is $400,000.

The Miller Carburetor Co., Los Angeles, Cal., contemplates the erection of a new plant for the manufacture of aluminum crankcases for automobiles and aeroplanes. H. A. Miller is president.

The National Engineering & Equipment Co., Seattle, will erect a new plant which includes a foundry, 80 x 100 feet; pattern shop, 20 x 30 feet; pattern storage, 20 x 32 feet and machine shop, 80 x 150 feet.

The Three Rivers Casting Co., Three Rivers, Que., Can., will build a foundry at an approximate cost of $35,000. A large amount of equipment will be purchased. A. B. Charleton is manager.

The Columbia Bronze Foundry Co., Camden, N. J., has been incorporated with a capital of $10,000 and a plant will be erected for the manufacture of brass and bronze castings. William Early, Frederick T. Hyde and A. J. Weeks are the incorporators.

The Light Mfg. & Foundry Co., Pottstown, Pa., manufacturer of aluminum specialties, is having plans prepared for an addition, 50 x 110 feet. The erection of two 3-story extensions, 30 x 175 and 50 x 200 feet, also are being considered.

The Aluminum Castings Co., Cleveland, will erect a new foundry and finishing plant at Manitowoc, Wis., 200 x 300 feet in size. The company's existing plant at Manitowoc recently was sold to the Aluminum Goods Mfg. Co., which takes possession when the new foundry is completed, Oct. 1.

The Western Malleable Co., Beaver Dam, Wis., is making a number of extensions and improvements. The core room of shop No. 3 is being rebuilt and is being converted into a 2-story pattern shop. Two truck ovens and two ovens of the drawer type will be installed in shop No. 3.

The Evinrude Motor Co., Milwaukee, has purchased a 10-acre site for a new plant which will consist of a gray iron and brass foundry and machine shop. The plans are being prepared by the Federal Engineering Co. The foundry will be 80 x 200 feet and will be equipped with a 60-inch cupola.

The Jewell Steel & Malleable Co. of California has been incorporated with $50,000 capital to erect a plant at San Francisco for the manufacture of steel and malleable castings. W. E. Jewell, of the Jewell Steel & Malleable Co., Buffalo, and A. Haase, William Lauten and C. S. Maltby, all of San Francisco, are interested in the new project.

The Standard Steel Castings Co., Cleveland, will enlarge its plant by the erection of an addition which will provide 15,000 additional square feet of floor space. Plans also are being prepared for another steel foundry to be erected in five units, each with a capacity of 1,000 tons of steel castings per month. Converters and electric furnaces will be installed.

General Industrial Notes

The Board of Education of Oakland, Cal., will increase the equipment of its school foundry.

The Superior Steel Casting Co., Benton Harbor, Mich., has purchased a tract of 17 acres to provide for future extensions.

The New England Foundry & Machine Co., Campello, Mass., has been incorporated with $10,500 capital. The directors are John G. Grant, Victor R. MacBain and L. F. Parks.

The Manitowoc Foundry & Machine Co., Manitowoc, Wis., has purchased approximately $5,000 worth of shop equipment.

The Modern Steel Casting Co., Milwaukee, has been incorporated with $25,000 capital by A. J. Deuser, Fred W. Biehn and William T. Hardy.

The Union Machine Works & Iron Foundry, Inc., Philadelphia, manufacturer of gray iron and steel castings, has purchased the buildings adjoining its plant, which occupy a floor area of 108 x 157 feet.

The International Castings Co., Rome, Ga., has been incorporated with $10,000 capital, by W. A. Smith and E. W. Kreider, to engage in the manufacture of stoves, ranges and hollowware.

The Donning Carburetor Corporation, Esopus, N. Y., has been incorporated with $300,000 capital to manufacture carburetors and engines. George W. Donning, R. Grant and A. K. Barker are the incorporators.

The Belding Foundry Co., Belding, Mich., has been incorporated with $25,000 capital and will take over the company of the same name, formerly owned by R. A. Stokoe. The plant will be enlarged and considerable new equipment will be installed.

The Singer Mfg. Co., Elizabethport, N. J., manufacturer of sewing machines, contemplates re-opening its foundry at Netcong, N. J., and it is also reported that its blast furnace at that place shortly, will be lighted.

The Van Wert Foundry Co., Van Wert, O., has been incorporated with $15,000 capital to take over the Van Wert Foundry plant and, it is reported also, the shop of the Delphos Foundry Co., Delphos, O. R. F. Marsh will be manager.

The Quincy Steel Casting Co., Quincy, Mass., has been incorporated with $25,000 capital by Roy G. Lundin, Dorchester, Mass., who has been elected president and treasurer, and Theo. Von Rosenvinge and O. F. Werstrom.

The Hercules Steel Casting Co., Milwaukee, shortly will select a site for its proposed foundry which will cost approximately $100,000. The offices of the company are in the Free Press building and E. B. Gennrich is secretary.

The Stroh Casting Co., Detroit, manufacturer of gray iron castings has succeeded the New Standard Foundry Co., of that city. During the past three years the melting capacity of this company's plant has been increased from 10 to 75 tons daily. A specialty is made of automobile castings.

The Lakewood Engineering Co., Cleveland, has taken over the plant of the Duplex Foundry & Mfg. Co., Elyria, O., which will continue to be operated under its present name. Considerable new equipment will be installed including a cupola. A. L. Ehrbar, formerly connected with the Dunham Co., Berea, has been elected president of the Duplex Co.

The Beckemyer Foundry Co., has been organized at Beckemyer, Ill., with a capital of $8,000 to engage in the operation of a foundry for the production of gray iron, semi-steel, brass and aluminum castings. A plant now is being erected, the main building of which will be 60 x 100 feet. The incorporators are H. O. Briefield and W. L. Timmons and W. G. Keller has been appointed general manager and superintendent.

The Bilton Machine Tool Co., Bridgeport, Conn., manufacturer of gray iron castings, machinery and tools, has been organized by the consolidation of the Standard Mfg. Co., and the Parsons Foundry Co., both of Bridgeport. The Standard Mfg. Co. was established in 1905 and the Parsons Foundry Co. in 1871. C. E. Bilton is president and treasurer of the new company.

NEW TRADE PUBLICATIONS

COMPRESSORS.—A 20-page, 6 x 9-inch catalog devoted to duplex steam-driven air compressors for the general industrial application of compressed air has been issued by the Ingersoll-Rand Co., New York. Tables of sizes and capacities are given and the catalog is thoroughly illustrated to show the machine in detail.

PNEUMATIC DRILLS. — The Ingersoll-Rand Co., New York, in a 40-page, 6 x 9-inch catalog, illustrates and describes a large variety of types and models of pneumatic drills and gives recommendations as to the particular character of the work to which they are adapted. Each tool is illustrated and tables are included giving the sizes and capacities of each tool.

BLAST GATES.—A new type of air-tight blast gate to control the air supplied to oil and gas furnaces, blacksmith forges, blast pipes, miscellaneous blowing operations, heating and ventilating work, etc., has been put on the market by the W. S. Rockwell Co., 50 Church street, New York. This gate is made of a casing in two parts containing a slide operating entirely within the casing. The slide is made of hard rolled brass and moves in a machined runway with just enough clearance to permit movement. The face of each half of the casing is also machined, thus forming an air-tight joint. The slide is moved by a handle which extends outside the casing through a stuffing box. The casing is tapped for standard wrought iron pipe, or may be provided with nipples for connecting with sheet iron pipe.